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MYSORE-MADRAS CAUVERY ARBITRATION, 1929

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MYSORE-MADRAS CAUVERY ARBITRATION, 1929.

VOLUME I.

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MYSORE-MADRAS CAUVERY ARBITRATION, 1929

OFFICIAL SUMMARY OF THE PROCEEDINGS.

MYSORE-MADRAS CAUVERY ARBITRATION, 1929.

OFFICIAL SUMMARY OF THE PROCEEDINGS.

Saturday, 25th May 1929.

The Chairman referred to clause 10 (xv) of the agreement of 1924 and said that the matter referred to arbitration related to the interpretation and carrying out of rule 8 of the agreement of 1924 and that the arbitrators in substance were invited to determine whether, and to what extent, the exact terms set out in rule 8 were to be adhered to, or in other words, whether computation of the limit of discharges from the river Cauvery into Madras, was to be finally settled upon the average of the curve of discharges in ten years, 1917—1926. He then called upon the parties to state generally the nature of the case which they proposed to present to the arbitrators.

Sir Chimanlal Setalvad for Mysore handed in a formal document embodying the case for Mysore and it was arranged that Madras should present a counter case on the following Tuesday. The Advocate-General on behalf of Madras, and Sir Chimanlal Setalvad on behalf of Mysore then, in general terms, stated what the substance of their respective cases were.

On behalf of Mysore Sir Chimanlal contended that in the agreement for the ten years' curve as the basis for settling the limit discharges, it was an implied term of the agreement that, during the ten years, the control works and the bed and banks of the river should remain in substantially the same condition as they were in, when the agreement was entered into and that, inasmuch as the state of control works and river was abnormally affected by the unprecedented flood of 1924, the years from the occurrence of flood should be excluded from the ten years, on the average of which the discharges should be fixed.

The Advocate-General urged that, if the contention of Mysore was that the effect of the flood rendered rules 8 and 7 unworkable, the result would be that the object of the agreement would be frustrated and if the agreement had come to an end, the arbitrators would have no jurisdiction, for, the issue to be submitted to arbitration was one of the clauses of the agreement which had come to an end. On the other hand, if it was contended that a term altering the number of years for the computation of the discharge thereby to be fixed, was to be implied, such a term would be inconsistent with the express terms of rule 8 and the effect would be that the arbitrators were asked to substitute a new contract for the one into which the parties had entered and that the arbitrators had no jurisdiction in that behalf. Further, such a term as was suggested by Mysore could only be implied, where the agreement otherwise would be unworkable and futile and Madras would contend on the facts that there was no foundation for the contention that any such terms should be implied in the agreement.

Saturday, 1st June 1929.

Mr. Justice Page addressing the Advocate-General, said that since they had met on the last occasion, the high contracting parties had agreed to an amended submission by which he was appointed sole arbitrator and that he would have the benefit of the assistance of Messrs. Howley and Forbes, who possessed engineering experience, in elucidating any points upon which he thought it advisable to seek their advice.

Sir Chimanlal Setalvad then proceeded to open the case for Mysore. He urged that the learned arbitrator should decide the matter, not by applying the principles of municipal law, but according to what was reasonable and just between the parties. He then stated the facts upon which Mysore founded their case and

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urged that the floods of July 1924 were of such an unprecedented character that it could not have been the intention of the parties, that the discharges based upon the gaugings after the occurrence of the floods, should be taken into consideration in fixing the volume of water to which Madras was entitled under the terms of the agreement of 1924. Sir Chimanlal then referred to the history of the case and traced the steps which were taken from time to time, to control the flow of the Cauvery river in the vicinity of the Cauvery Dam and further referred to and explained the provisions of agreements of 1892 and 1924. The Counsel was referring to the volume of water, which Madras claimed to be entitled to in order to satisfy her irrigation schemes at different stages in the history of the Cauvery irrigation, when the Court rose for the day.

Monday, 3rd June 1929.

Sir Chimanlal Setalvad continued his arguments on behalf of Mysore and explained how the discharges at the Cauvery Dam were ascertained. Having explained the nature of the agreements. Sir Chimanlal argued that if the discharges for the ten years 1917 to 1926 were taken for the purpose of computing the volume of water which must pass to Madras, the result would be that Mysore would not have sufficient water to irrigate either the 125,000 acres contemplated under the Krishnarajasagara Scheme or the additional 110,000 acres which it was contemplated Mysore would be able to irrigate after the surplus water which remained after the volume to which Mysore and Madras were entitled had been utilized.

Sir Chimanlal then pointed out the devastating effects of the floods of July 1924 and endeavoured to show from official reports that floods so violent and calamitous had never been known before and therefore provision had not been made to meet them in the construction of the works and they were not within the contemplation of the parties when the agreement was entered into. Sir Chimanlal was in the course of discussing the facts relating to the damage caused by these floods, when Mr. Justice Page rose for the day.

Tuesday, 4th June 1929.

When the sittings were resumed, Sir Chimanlal Setalvad submitted that, on the materials he had presented to the Court, the reasonable inference was that the floods were of a wholly unprecedented character and that the effect of the floods was to render impracticable the gauging of the discharge in the manner in which the parties had agreed to carry it out. He urged that unless the controlling works were *intact* the basis upon which the agreement to take the gaugings was founded would be destroyed. He then explained the nature of the changes in the dam itself and by maps and charts pointed out that the contention of Mysore was that, instead of the bed of the river being 2·85 feet above the crest of the dam, it had sunk to 1 foot below the crest of the dam, the result of scouring due to the violence of the flood. The result of this was that by taking the gaugings at the dam after the flood had occurred, Madras would obtain 3·85 feet more depth of water than it was the intention of the parties under the agreement that Madras should receive. He then proceeded by reference to reports by engineers before the flood took place, that it was not contemplated even by experts that a flood of this magnitude would occur and that no provision was made to withstand the effect of a flood such as that which occurred in July 1924. He then proceeded to show from figures and charts according to the contention of Mysore that at least from 1867 to 1924, the bed level of the river at the dam had remained in substance constant and invariable and he urged that the result of the flood was that it was no longer possible to gauge the discharges at the Cauvery Dam in the manner laid down and agreed to under the contract of 1924. At this stage the Court rose for the day.

[There was no sitting of the Court on the 5th June, but there was a meeting of the Counsel and Engineer Officers of Madras and Mysore as to which facts and figures might be accepted as common ground.]

Thursday, 6th June 1929.

Sir Chimanlal continuing his arguments upon the facts, pointed out that the contention of Mysore was that the bed of the river, owing to the silting of the sand at the Cauvery Dam, had risen 2·85 feet and this was a more or less constant factor from 1867 until 1924 when the floods took place and that the effect of the floods was to scour out the bed of the river, with the result that after the floods, the dam itself was breached and the bed of the river had fallen to 1 foot below the crest of the dam, making in all a difference of 3·85 feet in the gaugings at the dam. Upon the whole of the evidence Sir Chimanlal contended that the effect of the flood was that the method of computation by which the ultimate volume of discharge to Madras was to be assessed, was vitiated by the floods and that therefore the discharge curve of ten years could no longer be employed for the purpose of assessing the volume of water to which Madras was entitled. He then argued that under the agreement, the learned Arbitrator was entitled to settle the dispute by deciding what in his opinion was a fair amount of water to be awarded to Madras. He further contended that if the learned Arbitrator had no such jurisdiction under the agreement, the effect of the flood was that the method of computation was vitiated; the Court ought to imply a term that the assessment at the Cauvery Dam could only be carried out, upon the footing that the condition of the works at the river remained substantially the same as it had been since 1867, and therefore as the condition of the river had been altered, the parties would no longer be able to make the assessment as provided in rules 7, 8 and 10 of the agreement of 1924.

Friday, 7th June 1929.

Sir Chimanlal Setalvad concluded his argument on behalf of Mysore and the Advocate-General of Madras proceeded to open the case on behalf of Madras. After shortly referring to the history of the facts and the negotiations that led up to the agreement of 1924, the Advocate-General contended that the discharge curve of ten years was inserted in the agreement at the instance of Mysore, who insisted that rules 7 and 8 should be unalterable. He contended that in those circumstances it was not open to Mysore, which invoked the arbitration under the agreement, to contend that the agreement had itself come to an end. He urged that if the contention of Mysore was accepted, the result would be that no impounding at the Krishnarajasagara could take place and therefore the agreement itself was frustrated and with it the jurisdiction of the Arbitrator in clause 10 (xv).

Mr. Justice Page asked the parties having regard to the object of the proceedings, viz., to settle the matter in dispute, whether it was not advisable that the submission should be so framed as to give him power to deal with the matter as a whole and the learned counsel on both sides said that they both thought such a course, in their opinion, would be advisable.

The Advocate-General contended, however, that the subsistence of rule 7 was not dependent upon rules 8 and 10 and pointed out that Madras throughout the negotiations leading up to the agreement in 1924, had insisted that limit gauges to a certain height, and not discharges, were the essential features in any agreement between Mysore and Madras for the purpose of safeguarding the rights of Madras and he urged that if the computation under the ten years' gaugings was vitiated contrary to the view put forward by Madras, the result would be that Madras would still be entitled to receive water up to the limit gauges set out in the agreement, before Mysore could impound any water at the Krishnarajasagara.

At this stage the Court rose for the day.

Saturday, 8th June 1929.

The Advocate-General, continuing his argument on behalf of Madras, pointed out that throughout the proceedings leading up to the Arbitration of 1914 and from 1914 until the agreement of 1924, Madras had always insisted upon their prescriptive rights being measured by limit gauges up to certain heights and that

the equivalent in cusecs was not that for which Madras had insisted. He proceeded to refer to correspondence and official reports to bear out his contention that it was level and command which Madras was throughout insisting upon. He then urged that whereas Madras had originally claimed a uniform number of cusecs as being equivalent to a certain level at the Cauvery Dam gauge, that number of cusecs was to be uniform throughout eight or nine months of the year, but in the negotiations preceding the agreement of 1924, Mr. Howley, Chief Engineer, on behalf of Madras, had agreed to work out a graduated scale of levels which would have corresponding graduations in the cusecs. He then contended that rule 7 of the agreement of 1924 contains the limit gauges which would fix the minimum levels upon which alone Madras was content to enter into agreement having regard to the requirements of the Presidency, and that even if rule 8 by which the levels were resolved into cusecs, could no longer be worked, the effect would be, not that the agreement had come to an end, but that the parties were relegated to the rights under rule 7. Madras was entitled to the levels which the parties had agreed should be given to Madras under rule 7 of the agreement.

At this stage Mr. Justice Page rose for the day.

Monday, 10th June 1929.

The Advocate-General, Madras, continuing his argument contended that if the computation of discharges under rule 8 was vitiated, it would be practicable for the limit gauge readings under rule 7 to be taken, notwithstanding the existence of the Mettur Reservoir. He then proceeded to develop his case on behalf of Madras and pointed out that the Cauvery was known as the "River of Floods" and the land watered by it as "the Land of Floods." He then explained that water in a river picks up sand as it passes along its course; the greater the velocity of the river, the greater the power of picking up sand and of transportation of objects in the river. It followed the greater the velocity of the river, the greater the amount of sand picked up and the depth of the scouring. He then referred to the previous floods which had occurred in the Cauvery from 1853 onwards, some of which had caused breaches in the banks of the river and from reports and other documents he pointed out how frequent and how intense were the floods which occurred in the river Cauvery. In those circumstances, he urged that the parties must have had in contemplation at the time they entered into this agreement, the probability that floods would occur not only of a minor character, but of great intensity with catastrophic effects and that if the parties had intended to provide against the effects of violent flooding, such as was usual in the river Cauvery, a term to that effect would have been inserted in the agreement. The Advocate-General then proceeded to discuss and challenge the contention of Mysore that the bed level was constant from 1867 till 1924 and pointed out that in order to see whether the effect of the flood was that the bed level sank more than 3 feet, it was useless to take the average bed from 1867 or any other period prior to the occurrence of floods, the only practical data being a comparison between the state of the river immediately before the floods and its state after their occurrence and he urged that upon the figures which had been deduced, the bed of the river by reason of the floods had fallen not more than $1\frac{1}{2}$ feet. He was developing his argument when Mr. Justice Page rose for the day.

Tuesday, 11th June 1929.

The Advocate-General continuing his argument on behalf of Madras, contended that Madras under the agreement of 1924 was entitled to the levels connoted by the limit gauges down to the crest level of the dam. He contended that when the dam was constructed, it must have been put in level with the bed level of the river. Otherwise, it would either operate as an anicut or would not fulfil its purpose to prevent scouring, if placed below the bed level of the river. He then explained in detail from charts and graphs and figures upon which Madras relied and urged that the bed of the river after the floods had sunk not 3 feet as contended by Mysore, but

only $1\frac{1}{2}$ feet and never below the crest level of the dam. He challenged the principle upon which Mysore proceeded in urging that the level had fallen 3 feet, because he said that in order to discover how much the level had fallen by reason of the floods, it was necessary to take not the average bed level of the river from 1867 to 1923, but the level of the bed of the river just before the floods had occurred and compare that level with the bed level of the river after the floods. He contended upon the figures which he produced, that the bed level fell 1·50 feet by reason of scouring caused by the floods in 1924, but except on three days, it never fell below the crest level of the dam. He then proceeded to point out that between 1909 and 1913 and 1913 and 1923 there had been considerable variations in the levels of the river and further urged that the effect of the breaches below the dam did not materially affect or contribute to the lowering of the bed by scouring. He urged that the effect of a breach in the flood banks of the river was local. Even assuming that the outpouring of water through the breach might affect the velocity of the river and so induce scouring in the immediate vicinity, two breaches caused by the 1924 floods were 5 miles away from the dam and the third breach, 17 miles away and any action which might affect the velocity of the river in the vicinity of the breaches, could not affect in any way the velocity of the river at the dam or Meter Gauge section.

At this stage, the Court rose for the day.

Wednesday, 12th June 1929.

The Advocate-General continuing his argument, further challenged the statement that the breaches in the banks of the river below the dam had in any way affected either the scouring or the discharges at the Current Meter section and referred to the condition of the river at Urachi, 95 miles above the dam, where the surface is rocky and the soil more stiff than in the lower reaches of the river and pointed out that at Urachi the banks were 25 to 30 feet high and in the absence of any breaches the bed level was scoured from 2 to 7 feet. He argued that in those circumstances it could not reasonably be contended that the breaches had caused the scouring. He then referred to the breaches at Murungapet and Kilikkudu and contended that the breaches at those places could not affect the state of the river or the depth of the water at the dam. At Murungapet the water through the breaches returned to the Cauvery river and although the breaches were repaired in September 1924, neither in that year nor in 1925 was there diminution in the volume of the discharge. He then referred to a test laid down in Engineering Books from which he contended he could prove that the water at more than $2\frac{1}{2}$ miles away at a height of 7·5 feet would not be affected by a breach at Murungapet; *a fortiori* the water would not be affected at the dam, 5 miles away. He used this test not as being conclusive, but as an indication that if the surface of the water was not affected, the bed of the river likewise would not be affected by the breaches lower down the river. He then explained certain other tests which had been made, as the result of which he claimed to have proved that the bed of the river never fell lower than the crest of the dam and inasmuch as under the agreement, Madras was entitled to the limit gauges down to the crest level of the dam, Mysore had no ground to complain that as the result of the flood, Madras would obtain more water under the agreement than she was entitled to take. Then Mr. Justice Page rose for the day.

Thursday, 13th June 1929.

In the Cauvery Arbitration Court on Thursday in answer to His Lordship's question whether the case of Madras was that Madras was entitled to limit gauges of 7·5 at certain months from the crest of the dam and that Madras had not obtained by reason of the flood any volume of water through the bed of the river sinking below the crest of the dam and that the terms of the agreement had been carried out, the Advocate-General replied that that was the case of Madras and pointed out that the area of waterway which Mysore contended during the flood was 16,450 square feet by comparison with the area at the Meter Gauge section was not

more than 14,750 square feet. After dealing with certain other matters, the Advocate-General proceeded to sum up the case on behalf of Madras. He first stated that the claim of Mysore in substance was that by reason of the flood, the agreement of 1924 was frustrated. He challenged the contention and stated that nothing had occurred by reason of the floods of 1924 to vitiate the agreement. Madras had always contended that in order to safeguard her prescriptive rights, she was entitled to certain heights as fixed by limit gauges and whether or not the computation of cusecs estimated to be equivalent to the various heights was vitiated or not under rule 8 of the agreement, Madras was entitled to the limit gauges agreed to under rule 7. He did not admit, however, that rule 8 had become incapable of performance. On the contrary, all that had happened was that by reason of the flood, the discharge ultimately fixed under rule 8 was greater than otherwise it would be. But that was the risk which the parties took when the ten years' limit was agreed upon. Whether the agreement had worked out to the advantage or disadvantage of one side or the other depending upon the variations in the discharges in the several years, and whether the contract turned out to be profitable or unprofitable to either party, was immaterial for the purpose of determining the parties' rights and obligations under the agreement into which they had entered. He then recapitulated his arguments of the facts and contended that the average bed level was never below the crest level of the dam, that Madras was entitled to water within the limit gauges down to the level of the dam, that there was no particular reason why the dam should have been selected for the setting up of the limit gauges rather than any other portion of the stream, that the volume of water was the same within reasonable limits of the dam either way and that the maintenance of the dam was immaterial so far as the working of the limit gauges was concerned. He further contended that upon the evidence that he had produced, the reasonable inference to draw was that the breaches in the flood banks had not appreciably affected either the scouring or the volume of discharges in the river.

Having concluded his arguments upon the facts, the Advocate-General referred to the principles of law, which he contended ought to be applied and contended that there was no ground for applying the principle of frustration to the agreement in suit. He was referring to the legal authorities upon the frustration of contracts when the Court rose for the day.

A. Page,
Arbitrator.

Friday, 14th June 1929.

[No official summary of the Proceedings of the 14th June 1929 was issued. The Advocate-General continued his reference to the legal authorities bearing upon the case and closed his arguments that afternoon. There were no further sittings of the Court, as the two Governments have entered into a compromise.]

MYSORE-MADRAS CAUVERY ARBITRATION OF 1929.

Statement of case by Mysore.

The Cauvery River originating in the Province of Coorg flows through the Mysore territory and thereafter through the territories forming part of the Madras Presidency. At Srirangam Island, it divides itself into two, one branch being called the Cauvery and the other, the Coleroon. Near the eastern end of the Srirangam Island, the Cauvery proper breaks up into two parts, one being called the Cauvery and the other, the Vennar. Further down, the Cauvery and the Vennar break up into various different channels and irrigate what is known as the Cauvery delta in the Tanjore District.

2. The various controlling works at the western end of the Srirangam Island as well as at the eastern end are shown in the sketch hereto annexed and marked " A ". The controlling works at the western end of the island consist of—

- (*a*) the Upper Anicut across the Coleroon;
- (*b*) the Cauvery Dam across the Cauvery;
- (*c*) 150 yards kalingula.

At the eastern or the lower end of the Srirangam Island, there are—

- (*d*) the Grand Anicut between the Cauvery and the Coleroon; and
- (*e*) the Cauvery and the Vennar Regulators.

All the distance between the eastern and the western ends of the Srirangam Island, the river Cauvery had protective flood banks on both sides till the events of 1924, hereinafter referred to, took place.

3. The Cauvery Dam which is 1,950 feet in length is of the nature of a floor or grade wall intended to prevent erosion of the bed and margins of the Cauvery at the head of the Srirangam Island. The natural bed of the river was at a mean level of 2·83 feet above the crest of the Dam from 1867 to 1898–99 and after the remodelling of the Upper Anicut which took three years, the mean bed level was 2·85 feet above the crest of the Dam from 1902–03 to 1910–11 and continued about the same up to the breaching of the Dam in July 1924.

4. Besides the Cauvery, there are other rivers that similarly flow through the Mysore territory into Madras territory.

5. As necessity arose for the development of irrigation works in Mysore as well as in Madras, and, for utilizing for that purpose the waters of the various rivers flowing through these territories, it was thought desirable by the two Governments to arrive at some understanding in the matter. After considerable negotiations, an agreement was arrived at on 18th February 1892, whereby certain rules were accepted by both the Governments. Under the said rules, the Madras Government was bound to give their consent to the construction of new irrigation reservoirs by the Mysore Government, provided the prescriptive rights already acquired by the Madras Government were secured, the existence, extent and nature of such rights being in every case determined in accordance with the law of prescriptive rights and with what is fair and reasonable under all the circumstances. The full text of clause III which deals with this matter, runs as follows :—

"When the Mysore Government desires to construct any 'New Irrigation Reservoir', or any new anikat requiring the previous consent of the Madras Government under the last preceding rule, then, full information regarding the proposed work shall be forwarded to the Madras Government and the consent of that Government shall be obtained previous to the actual commencement of work. The Madras Government shall be bound not to refuse such consent except for the protection of prescriptive right already acquired and actually existing, the existence, extent, and the nature of such right and the mode of exercising it being in every case determined in accordance with the law on the subject of prescriptive right to use of water and in accordance with what is fair and reasonable under all the circumstances of each individual case."

6. By clause IV, it was provided that, should a difference of opinion between the two Governments arise in any case under rule III, the same should be referred to the final decision either of arbitrators appointed by both the Governments, or of the Government of India.

7. In the year 1910, the Mysore Government was desirous of constructing a reservoir at Kannambadi—which reservoir is now known as the Krishnarajasagara—and it became necessary under clause III of the said rules to apply for the consent of the Madras Government. As the two Governments could not arrive at an agreement on the matter, the question was referred to arbitration under clause IV of the rules. The arbitrator, Sir H. D. Griffin, who was assisted by an expert engineer as assessor, made his award in 1914 and that award was ratified by the Government of India. That award held that the Madras Government were entitled, from June to January both inclusive, to a limit flow of 22,750 cusecs, for the requirements of their existing irrigation, equivalent at the time of the award to a gauge reading of 6·5 feet at the Cauvery Dam on the North Gauge. The award further gave detailed directions as to the manner of impounding the waters of the Cauvery by the Mysore Government at the Krishnarajasagara Reservoir so as to secure to Madras the above quantity of water.

8. The Madras Government having invoked the interference of the Secretary of State, the two Governments entered into further negotiations. In the year 1921, the technical officers of the two Governments came to an agreement to substitute another set of rules of regulation of the Krishnarajasagara Reservoir in place of those framed by the arbitrator, subject to ratification by their respective Governments. These new rules provided for the regulation and the impounding of the waters at the Krishnarajasagara Dam and passing on the quantity of water due to Madras. As the Madras Government wanted various other matters, specially the further expansion of irrigation in Mysore and Madras respectively, also to be settled, the negotiations dragged on till the 18th of February 1924, on which date an agreement was signed on behalf of both the Governments whereby the said new rules of regulation were adopted. Among other things, the said agreement by clauses 4 and 5 provided that Mysore was at liberty to carry out further extension of irrigation under the Cauvery and its tributaries to an extent of 110,000 acres in addition to the area of 125,000 acres permissible under the rules of regulation *plus* one-third extension over the area actually under irrigation prior to 1910.

9. At the date of the agreement, the parties had before them the results of the joint gaugings for seven years from 1917 to 1923, both inclusive, and Madras, when it signed the agreement in 1924, was evidently satisfied with the quantities it would have got till then under the rules, and what in the ordinary course it expected to get on the 10 years' average, in the light of the experience of the seven years. On the average for seven years, Madras would be getting 39,086 cusecs for $7\frac{1}{2}$ feet gauge, while their highest claim before the Government of India and the Secretary of State was 34,062 cusecs from June to January, including the spill over the Upper Anicut.

10. Under rule 10 of the said rules regulating the discharge through and from the reservoir, the impounding of water in the Krishnarajasagara in the irrigation season was to be regulated in accordance with the following formula:—

$$I = \frac{Kn}{P} - C$$

For the purpose of this formula, the inflow at Krishnarajasagara, viz., Kn was to be measured in the manner indicated in the rules. This inflow figure was to be divided by P, being the proportion that the natural flow in the Cauvery at the Krishnarajasagara might bear to the corresponding natural flow at the Upper Anicut. From the resultant figure was to be deducted C, which indicates the limit quantities of water which Madras is entitled to receive at the Cauvery Dam in different months. These limit quantities for different months were to be deduced from the average discharge curve derived from the joint gaugings at the Cauvery Dam in the manner provided in rules 7 and 8. P for the purposes of the ten years' experimental period was fixed at ·625 for the south-west monsoon and ·300 for the north-east monsoon. But for all subsequent regulation after the ten years' period, P was to be revised on the basis of the gaugings of the ten years in the manner provided in rule 11.

11. The joint gaugings were actually being taken about 900 feet below the Cauvery Dam, the site being called the Current Meter Section. The said discharges had to be finally revised and adopted after 1926 for all subsequent regulation on the basis of joint gaugings of the 10 years ending 1926. When the limit discharges for the different months had been so finally revised and adopted for all subsequent regulation as aforesaid, there was no further use of the limit gauges mentioned in rule 7.

12. The joint gaugings as provided in rule 8 were taken in the years 1917, 1918, 1919 and 1920 and the average discharge curve derived by such joint gaugings for the said four years was used for 1921. The said discharges were further revised after completion of the joint gaugings of 1921 for being used for the purpose of regulation for the five years ending 1926.

13. On or about the 20th of July 1924, there were extraordinary and unprecedented floods in the Cauvery which seriously damaged some of the controlling works and very materially altered the physical configuration of the river :—

(*a*) The Cauvery Dam was destroyed to the extent of about 900 feet and the rest of the Dam was also seriously damaged. The 900 feet of the Dam destroyed by the floods was rebuilt by June 1926 thirty feet higher than the remaining portion of the original Dam and was joined by a cross wall to the remaining portion of the old Dam. The reconstruction of another 800 feet of the original Dam was projected in 1927 and it was under consideration whether the remaining 300 feet length of the original Dam should not also be reconstructed owing to its damaged condition.

(*b*) The Current Meter Section got widened by about 80 feet and remained in that condition to the end of the gauging season of 1926.

(*c*) The bed of the river both above and below the Dam was heavily scoured and, in consequence, the bed which was at a mean level of 2·85 feet above the crest of the dam since 1902 sank to about a foot below the crest of the Dam, thus making a total difference of 3·85 feet as compared with the condition of the bed before the breaches of 1924.

(*d*) The flood banks from the Dam to the Grand Anicut were breached on both sides in several places.

14. As a consequence of the above damages, discharges at the Cauvery Dam have abnormally increased, gauge for gauge, as will be seen from the drawing hereto annexed and marked " B ".

15. The changes in the bed caused by the extraordinary floods are likely to continue in more or less degree for some years and it is difficult to foresee when and whether the old regimé, which was the one in the contemplation of the parties at the time of the agreement, would be restored.

16. When the two Governments entered into the Agreement of 1924, it was on the assumption of the continued existence of the control works, the river bed and banks in the same state in which they had been for a long number of years within the knowledge of the parties, subject to normal and seasonal variations of the bed and the natural banks, during the period of the 10 years for which gaugings had to be taken, and such continued existence was the foundation of the agreement. On a proper construction of the contract, the continued existence of the above state of things must be read into it as an implied condition. If such a material alteration in the existing state of things, by an act of God of the character that supervened, had been thought of by either party as a possible contingency that might occur during the currency of the agreement, an express provision would certainly have been made, so as to exclude from computation the gaugings subsequent to the altered conditions in arriving at the final average curve of discharge under Rule 8. There was, in effect, an implied warranty that the state of the controlling works and that of the bed and banks of the river would remain unaffected, subject only to normal and seasonal variations, throughout the experimental period of ten years. If the gaugings of the two and a half years subsequent to the floods are taken into account, C in the impounding formula will have an abnormally higher value, thus reducing the quantity impoundable by Mysore. Further, with the inflation of C, the number of impounding days will be reduced.

17. The Mysore Government contend that the very foundation and basis of the agreement in this respect have disappeared by events which could never have been in the contemplation of the parties when they entered into the agreement, and that, owing to the implied condition not being fulfilled, the agreement has become incapable of performance without destroying the very object and purpose of the agreement. It follows, therefore, that the gaugings taken from and after the breaches in July 1924, cannot be taken into account for the purpose of determining the average limit quantities to be given to Madras and also for examination under clause 11. The only object of having a period of 10 years was to arrive at a fair approximation by taking the gaugings over an extended period. As, under the circumstances aforesaid, the 10 years' experiment cannot be carried out, the data for seven and a half years up to the date of the breaches in July 1924 afford a sufficient and fair basis for arriving at a proper approximation.

18. Even if the basis of the $7\frac{1}{2}$ years' average is adopted, there will not be sufficient water once in 10 years for irrigating the 125,000 acres under the Krishnarajasagara Scheme, while there will be no water available for several years for the irrigation in Mysore of the additional 110,000 acres as contemplated by the agreement. On the other hand, Madras will always get quite a sufficient supply not only for their existing irrigation of nearly 1,250,000 acres, but also for the additional area of 301,000 acres under the Mettur Scheme. If the 10 years' average is taken as contended by Madras, the Krishnarajasagara scheme will fail very badly in three years out of ten and there will be no water available for additional irrigation which the agreement was intended to secure for Mysore. Madras, on the contrary, will get much more than what they require for their purposes under the agreement, with the result that the surplus water must run to waste to the sea.

19. Clause 15 of the agreement of 1924 runs as follows :—

"The Madras Government and the Mysore Government hereby agree that if at any time there should arise any dispute between the Madras Government and the Mysore Government touching the interpretation or operation or carrying out of this agreement such dispute shall be referred for settlement to arbitration or if the parties so agree, shall be submitted to the Government of India."

20. As the two Governments were unable to agree regarding the interpretation, operation and carrying out of the agreement of 1924 in this behalf, the matter is now referred to arbitration for finding a settlement of the deadlock that has occurred. Mysore submits that the Arbitration Board has to find a settlement that would be reasonable, fair and equitable under the circumstances, and further that a settlement on the basis of the gaugings of the pre-breach period will satisfy this condition.

OOTACAMUND,
25th May 1929.

9

MYSORE-MADRAS CAUVERY ARBITRATION OF 1929.

Mysore demand for admission by Madras.

The position and course of the Cauvery River and the various controlling works at the western and the eastern ends of the Srirangam Island, and the dates of their construction are correctly shown in the accompanying sketch and marked "A".

2. The mean bed level of the Cauvery at the Cauvery Dam was 2·83 feet above the crest of the Dam from 1867 to 1898–99 and after remodelling of the Upper Anicut, it was 2·85 feet from 1902–03 to 1910–11.

3. On or about the 31st of July 1924, there was extraordinary and unprecedented flood in the Cauvery with the result that—

(*a*) the Cauvery Dam was destroyed to the extent of about 900 feet and the rest of the Dam was also seriously damaged;

(*b*) the Current Meter Section was widened by about 80 feet and also deepened and remained in that condition till the end of the gauging season of 1926;

(*c*) the bed of the river, both above and below the Dam, was heavily scoured and in consequence, the bed, which was at a mean level of 2·85 feet above the crest of the Dam since 1902, sank to one foot below the crest of the Dam; and

(*d*) the flood banks from the Dam to the Grand Anicut were breached on both sides in several places.

4. The 900 feet of the Dam destroyed by the floods was rebuilt by June 1926 at a point 30 feet higher than the remaining portion of the original Dam and was joined by a cross wall to the original Dam. The reconstruction of another 800 feet of the original Dam was projected in the year 1927 and it was under consideration whether the remaining 300 feet length of the original Dam should also not be reconstructed owing to its damaged condition.

The section showing the variations in the bed levels of the Cauvery at the Cauvery Dam during the years 1918 to 1926 is based on the river ~~charts received from Madras~~ sections jointly and it is correct.

5. The results of the joint gaugings taken from 1917 to 1926 are correctly shown in the appended statement and marked "B".

6. The proposed waste-weir capacity of the Mettur Dam was considerably increased after the floods of 1924.

B

Limit discharges over Cavery Dam in cusecs for different years, from 1917 to 1926.

Gauge in feet.	1917.	1918.	1919.	1920.	1921.	1922.	1923.	1924 pre-breach.	1924 post-breach.	1925.	1926.
3·00	..	5,640	7,230	5,930	4,760	4,250	4,030	5,530	10,100	10,800	7,700
3·50	..	8,440	9,860	7,950	6,510	6,710	5,700	7,520	13,400	14,500	10,700
6·00	24,800	24,300	26,000	24,000	22,800	23,700	19,500	23,100	35,900	37,000	33,700
6·50	29,200	29,800	30,400	28,500	27,500	28,200	25,000	28,200	41,900	43,000	39,500
7·00	34,200	35,500	35,300	33,200	32,200	32,800	32,100	33,900	48,800	49,100	45,300
7·50	39,500	39,850	40,200	38,100	37,700	37,800	39,300	39,300	56,600	55,400	51,100

BANGALORE,
24th April 1929.

MYSORE-MADRAS CAUVERY ARBITRATION OF 1929.

Replies to Mysore demand for admission.

Paragraph 1.—The sketch " A " is a reproduction of an old plan prepared by Madras about fourteen years back, with some additional information now noted thereon. The crest level of the Grand Anicut is 189·30 and not 188·92. The sill of the new scouring sluices is about 10 feet below the Grand Anicut crest and 5 feet below the sill level of the regulators, or at a level of 179·25. A bed regulator has also been constructed some distance above the scouring sluices. The actual distance between the Cauvery Dam and the Cauvery Vennar regulators as per more recent measurements is 17 miles 1 furlong. The distance of the old Vennar head above the Cauvery Vennar regulators is 2½ miles.

Paragraph 2.—The figures given here are taken from a statement given by Madras in the course of the 1913–14 Arbitration Proceedings (page 306 of the Madras edition of Madras Exhibits). The Mysore statement does not bring out the fact that there were no figures available for the years from 1868 to 1884, and that the average figure of 2·83 is based on the average for the years from 1885–86 to 1898–99, and not as the statement would suggest the average from 1867 to 1898–99. Nor does it bring out the fact that there were changes in the bed levels during the several years.

A copy of the original statement of Madras is given below :—

Years.	Above Cauvery Dam crest 236·24	Reduced mean bed levels of the Cauvery at Cauvery Dam.	Remarks.
1867	2·26	238·5	From old section.
1885–86	2·86	239·10	
1886–87	2·14	238·40	
1887–88	2·64	238·88	
1888–89	3·17	239·41	
1889–90	3·11	239·35	
1890–91	2·72	238·96	
1891–92	3·13	239·37	
1892–93	2·96	239·20	
1893–94	2·85	239·09	
1894–95	2·94	239·18	
1895–96	3·44	239·68	
1896–97	2·90	239·14	
1897–98	2·08	238·32	
1898–99	2·64	238·88	
Total ...	39·58		
Average ...	2·83		
1899–00	2·07	238·31	
1900–01	4·03	240·27	
1901–02	...	...	No chart map available.
1902–03	2·90	239·14	
1903–04	2·88	239·18	
1904–05	2·50	238·74	
1905–06	2·28	238·52	
1906–07	2·79	239·03	
1907–08	3·28	239·52	
1908–09	3·35	239·59	
1909–10	2·98	239·22	
1910–11	2·68	238·92	
Total ...	25·64		
Average ...	2·85		

Paragraph 3.—(*a*) Damage or destruction to a length of about 800 feet admitted. As regards the remaining length there was no serious damage, but only slight damages here and there.

(*b*) It is denied that the Current Meter Section was widened by 80 feet. A statement of the average width at the section during the years 1923 to 1926 for a stage corresponding to 7·5 on the Cauvery Dam North Gauge is given below :—

Year.	Width at water level.
	FEET.
1923	1,998
1924 (before floods)	2,006
1924 (after floods)	1,986
1925	2,018
1926	2,023

That the Current Meter Section was deepened is admitted. But it did not remain in the same condition till the end of the gauging season of 1926. There was gradual silting up during the period.

(*c*) The statement is denied. The figure of 2·85 was merely the average for the years from 1899 to 1910 taken during the summer following each year. In the summer of 1924 the average depth of silt was 2·09. In January 1925 according to the joint levels taken by Madras and Mysore it was 1·03 as per figures now furnished by Mysore and 0·82 as worked out by Madras. In the summer of 1925 it was 0·91.

That the bed level sank to one foot below the crest of the Dam is also denied. The average bed level at the Current Meter Section shows that the average bed level at the Cauvery Dam could not have fallen below the crest level.

(*d*) That there were breaches in the flood banks between the Cauvery Dam and the Grand Anicut is admitted. The nearest breach, that at Murungapet, was 5 miles below the Dam. It was closed by the first week of September.

Paragraph 4.—Admitted subject to the remarks —

(*a*) that 828 feet should be substituted for 900 feet.

(*b*) that the reconstruction of 300 feet was not under contemplation.

The sections for August 1918, June 1923, January 1925 and June 1925 are admitted.

Section for December 1923.—From 1,550 to 1,800 bed levels have been shown as 236·24, whereas they were actually lower. The following are the correct figures :—

Distances ...	1,550	1,600	1,650	1,700	1,750	1,800
Levels ...	235·92	235·94	236·03	236·03	236·06	236·00

Section for December 1926.—The levels shown for the portion 1,150 to 1,800 have been taken along the old line of the dam, whereas levels along the new dam line also were available. With this remark the section is admitted.

Section for 1924 *after breach*.—(1) The red figures shown in the section were taken in January 1925 and not in 1924 after breach as the plan would suggest.

(2) The figures shown are not those with reference to actual bed conditions, due regard being had to the shoal on the left side and the silt on the right, but are those arrived at by probing through the sand down to masonry below.

It is not admitted that the figures so arrived at represent the bed levels at the dam site. In consequence the figures given in the tabular statement shown at the foot of the section sheet against "1924 (after breach)" are not admitted.

Similarly again, the areas for 7·5 feet gauge shown in the tabular statement having been deduced from days when the water level was much below this stage, the suggestion contained therein that these would have obtained when the readings were at 7·5 is not admitted.

Paragraph 5.—Admitted except the figure of 39,850 for 7·50 in 1918. This figure should be 41,000 as deduced from the accepted figure for the average of the five years 1917 to 1921.

Paragraph 6.—The waste weir capacity is proposed to be increased.

OOTACAMUND,
27th May 1929.

11

MYSORE-MADRAS CAUVERY ARBITRATION OF 1929.

TERMS OF SUBMISSION.

The submission to the Tribunal of Arbitration under clause 10 (xv) of the agreement of 1924 is the dispute that has arisen between the Governments of Mysore and Madras touching the interpretation, operation and carrying out of the said agreement of 1924 in respect of rules 7 and 8 and of rules 10 and 11 (in so far as they bear upon rules 7 and 8) of the Rules of Regulation being Annexure I to the said agreement.

31*st May* 1929.

A. G. LEACH,
Secretary to the Government of Madras,
Public Works and Labour Department.

31*st May* 1929.

K. R. SESHACHAR,
Secretary to the Government of Mysore,
Krishnarajasagara Works.

12

MYSORE-MADRAS CAUVERY ARBITRATION OF 1929.

Counter-statement to the statement furnished by the Mysore Government.

1. The Madras Government contends that the plea outlined in the various paragraphs of the statement of Mysore and in particular the averments in paragraphs 16 and 17 are tantamount to a plea on the part of the Government of Mysore that the agreement of 1924, in so far as it secures the rights of Madras, has become void and inoperative. The Madras Government contends that on such a plea it is not open to the Mysore Government to invoke the jurisdiction of an arbitral tribunal constituted and the reference to which is submitted under clause 10, sub-clause (xv) of the agreement, which proceeds on the footing that the contract is alive and is in full force and that the tribunal is called upon to interpret the agreement and adjudicate on the rights of the parties as per the terms of that agreement.

The Madras Government maintains that, being a party to a reference under clause 10, sub-clause (xv) of the agreement, it is not open to the Mysore Government to take up the position that the agreement has become incapable of performance for the reasons alleged in paragraphs 13 to 18 of the statement.

2. The primary agreement between Madras and Mysore in regard to the rights of Madras is that contained in clause 7 of the technical agreement. Clause 8 was intended to take the place of clause 7 and to operate as a substitute for it after the ten years 1917 to 1926 referred to in clause 8. If for any reason clause 8 cannot be given effect to as the Mysore Government contends and the agreement contained in clause 8 ceases to be operative or becomes void, the Madras Government contends that the rights under clause 7 will continue intact, unimpaired and unaffected and their rights under the said clause will have to be worked out with reference to the existing river conditions as if the parties have not provided for any standard, measure or substitute for that agreement.

3. The Madras Government contends that, on the footing that the agreement subsists, it is not open to Mysore to read any terms into clause 8 inconsistent with its express terms by implication or otherwise. The Madras Government contends that this tribunal has no jurisdiction to imply any such terms into the agreement and to substitute a period different from what is provided for in clause 8. The Madras Government maintains that by no process of interpretation could the first seven years or any other period be substituted for the ten years specifically referred to in the agreement and stated in terms to be unalterable in the agreement between the parties.

On the plea in paragraph 17 of the statement that the very foundation and the basis of the agreement have disappeared, the Mysore Government cannot ask the tribunal to substitute an arbitary period of seven and a half years, simply because it suits the convenience of Mysore or the same operates to the advantage of Mysore.

4. If it is permissible (and it has already been stated that such a thing is not permissible) to read any terms by implication into caluse 8 on some theory of normal maximum flood, this tribunal will have necessarily to procced on the footing that in the years 1924 to 1926 the floods might have reached that maximum point, make provision for maximum discharges, gauge for gauge, and arrive at an average on that basis or in any event to add on the two or three years subsequent to the flood to the pre-flood period and work out the average.

5. Paragraphs 6 to 8 of the statement furnished by Mysore do not correctly set out the circumstances that led up to the agreement of 1924. The Government of Madras have set out in paragraphs 6–7 *infra* the circumstances that led up to the agreement of 1924 and the facts connected therewith.

6. Serious disputes had arisen between the Government of Madras and the Government of Mysore over the proposed construction of the Krishnarajasagara reservoir and in regard to the respective rights of Mysore and Madras under the agreement of 1892. Madras took up the position that it would not be feasible for Mysore to have any construction with the proposed capacity so as not to interfere with the rights of

Madras under the agreement of 1892 and its rights as a lower proprietor. The matters in dispute between the two Governments were referred to arbitration. In the course of the arbitration proceedings, Madras raised the following contentions *inter alia* that as lower proprietors, they were entitled to the full and unimpeded flow of the waters of the Cauvery, that the agreement of 1892 on a proper construction does not derogate from the exercise of such a right, that even as per the terms of the agreement of 1892, they were entitled to a 7 feet limit as per the Cauvery Dam North Gauge and that in addition they were entitled to one foot of water over the Upper Anicut prior to its remodelling. Mysore resisted the claim of Madras and contended that the rights of Madras were defined by the agreement of 1892, that they were entitled only to 6 feet reading as per the North Gauge and that the enjoyment of Madras must be restricted to the particular area under cultivation.

7. The award of the arbitrator recognized the rights of Madras to 6·5 feet, translated the same into discharges as per the data then available and provided for the same being uniformly secured for all months to Madras out of the natural flow. The award also gave an option to Madras, if it so chose, to have varying readings for different months. On an appeal preferred to the Government of India and then to the Secretary of State, the Secretary of State in his memorandum received with the Government of India letter No. 4731-I-B, dated 8th November 1919, vacated the award of the arbitrator and directed that his decision should be communicated to the Darbar and that if the Darbar so wished, it might submit a representation against the cancellation of the award. The Secretary of State suggested that if the Darbar preferred to waive an appeal, it would be open to the Darbar to enter into negotiations with the Government of Madras with a view to a decision being reached out of court or submit the main questions to arbitration by a new tribunal without further delay. In the memorandum annexed to the Government of India letter referred to above, the Secretary of State pointed out that Madras was enjoying a gauge reading of 7 feet at the Cauvery Dam and occasionally a gauge reading of 7·5 feet and that the award, in so far as it conceded only 6·5 feet, was obviously unsustainable. Mysore accordingly entered into negotiations with Madras and throughout the negotiations Madras insisted upon a definite gauge reading being assured, in order that it might secure the necessary command for the large and extensive tract of land under cultivation with the channels taking off from the Cauvery. With a view to give a quietus to the disputes outstanding between the parties at the time of the arbitration, an agreement was ultimately reached on the basis that definite gauge limits should be secured to Madras, though varying in different months of the year. The parties also agreed that the discharges connoted by the gauge readings should be observed for a period of ten years and that at the end of the period, the average discharges corresponding to each gauge reading should be substituted for the limit gauges.

8. The Madras Government states that the whole basis of Madras agreeing to the Mysore Government constructing the reservoir and impounding the waters of the Cauvery, was the minimum flow as per clause 7 and clause 8 being secured to Madras.

9. The agreement expressly states while certain rules in the agreement may be altered that *inter alia* rules 7 and 8 are unalterable, thereby clearly indicating that the period of ten years in clause 8 is of the essence of the contract.

10. The Madras Government states that by the terms and the spirit of the agreement and according to the common intention of both the parties either party was to have the full benefit and be subject to the risk of the working out of clause 8 in its entirety operating in their favour or to their disadvantage.

11. The allegations in Mysore statement in the different paragraphs are dealt with *seriatim* below.

12. *Paragraph* 1 *of Mysore statement.*—The Cauvery irrigates not merely the Tanjore District, but a very large extent of land (about 100,000 acres) above the Srirangam Island or above the point where the Cauvery and the Coleroon bifurcate by means of channels taking off from different places above that point. There is also a large extent of land irrigated by the waters of the Coleroon. In addition there is also an extent of about 27,000 acres of French territory to be irrigated under the Cauvery.

13. *Paragraph* 2 *of Mysore statement.*—The Cauvery Dam was not a controlling work as alleged therein. When the same was constructed, the crest level of the Dam was on a level with the bed of the river though it later got silted up and there was a rise in the bed level. If ever it functioned as a controlling work in the sense of its being a bed regulator, it had long ago ceased to be such and at any rate after the remodelling of the Upper Anicut. Originally at the Upper Anicut there was a regular masonry structure 6 feet above the bed level. In or about 1902 it was converted into a regulator, the Dam being lowered by 4 feet and movable shutters being provided. The 150 yards calingula is a surplus escape which admits of a portion of flow in the Cauvery at certain stages getting into the Coleroon which is utilized for Coleroon irrigation. The Grand Anicut and the Cauvery Vennar regulators, being controlling works, have no bearing on the points at issue in this case. The Cauvery banks continue to exist and to be maintained except in a few places ~~where~~ there were breaches, which breaches themselves were closed as soon as practicable and shortly after.

14. *Paragraph* 3 *of Mysore statement.*—It is not correct to speak of the conditions of the bed in which the crest of the dam was covered with silt as the natural bed. The natural bed of the river was at the sill level of the dam until it was silted up and the bed level consequently rose. The statement as to 2·83 feet is misleading. The depth of the silt has been fluctuating and the annexed table (Appendix I), from which apparently Mysore has taken the figures, will bear this out. The statement as to 2·83 feet being the mean level from 1867 to 1898–99 conveys a wrong impression. From 1868 to 1884 no figures are available. The average of 2·83 feet is computed with reference to the figures from 1885 onwards up to 1898 and does not take in the figures of 1867. An examination of the figures since 1899–1900 (vide sheet appended, Appendix I) shows that, whereas the depth of silt was 2·07 feet above the crest level in 1899–1900, in 1900–01 it was 4·03 feet, there being a difference of 1·96 feet within one year in the depth of silt and the consequent bed level. Again, in 1902–03 it came down to 2·90 feet, there being a scouring of the bed to the extent of 1·13 feet. The suggestion sought to be conveyed that the bed level continued to be constant is incorrect and misleading. There have been fluctuations in the bed level due to the silting and the scouring of the bed. The mean or the average depth of silt for all the years 1911–12 to 1923–24 would not be more than 1·95 feet.

15. *Paragraph* 8 *of Mysore statement.*—It omits to set out that the liberty to carry out further extension of irrigation by the Mysore Government is subject to the minimum flow being secured to Madras as per the rules of regulation.

16. *Paragraph* 9 *of Mysore statement.*—The statement therein is inaccurate and misleading. Madras denies that it was satisfied with the quantities it got up to the signing of the agreement in 1924. The technical agreement was signed in 1921 and the ten years' average was fixed upon even then. There were negotiations after 1921 with regard to certain other matters. During the progress of these negotiations both parties proceeded on the footing that the technical agreement of 1921 should remain unaffected. It is not true that the Madras Government was ever satisfied with the quantities it would have got till then under the rules or that it was all that they expected to get. Both sides were insistent on actual gaugings being taken down to the period of ten years in order that either party may have the full benefit and be subject to the risk of any possible loss. But for the fact that both parties have agreed to the average standard of ten years being substituted for the gauge readings under clause 7 of the agreement, Madras would, under the terms of that clause, be entitled to the limit gauges specified therein and the result would be that under the present river conditions, Madras would get much more discharges than the average under clause 8. But as a matter of fact, as a result of the average, Madras gets less than the limit gauges it has stipulated for under clause 7 as a condition of Mysore constructing the Krishnarajasagara and the impounding of ~~the~~ water therein. That the condition as to ten years' average is of the essence of the contract would be evident from the circumstance that Madras at one stage of the negotiations prior to the agreement suggested a shorter period, but Mysore insisted on a ten years' average being substituted to provide against all sorts of variations.

17. *Paragraph* 10 *of Mysore statement.*—It omits to state that the value of P, viz., ·625 and ·300, are only the minimum. The agreement provides that the revision of P can only be by way of increase, the figures ·625 and ·300 being taken as an irreducible minimum.

18. *Paragraph* 12 *of Mysore statement.*—The statement that the average discharge curve derived by joint gauge readings for the four years 1917 to 1920 was used for 1921, is not correct as the agreement was ratified only in 1924 and till then the regulation was in accordance with the award rules of regulation.

19. *Paragraph* 13 *of Mysore statement.*—With reference to this paragraph the Madras Government states that the flood of the gravity and of the kind that has occurred in the Cauvery in 1924, is just what might be expected in the case of a river like the Cauvery and must be deemed to have been in the contemplation of the parties, having regard to the nature and general conditions of the river. There is no greater difference in regard to the magnitude of the flood and the effects produced between the floods of 1911 and 1924 than between the floods of 1896 and 1911. In the past the flood level varied up to 14·2 feet. There have been changes in the bed level either by way of silting or scouring. The discharges have varied and breaches have occurred. Floods of varying magnitude and changes in the river conditions have always been treated as a normal feature of the Cauvery, the land through which the river flows being described as a land of floods. In the circumstances above mentioned, the Madras Government states that when the agreement was entered into, the change in the river conditions in the sense above referred to and the variations in the discharges corresponding to the limit gauges stipulated for, were and must be deemed to have been in the common contemplation of the contracting parties.

The Madras Government denies that there is any alteration in the physical configuration of the river.

(i) *Clause* (*a*).—The Mysore Government has exaggerated the damage consequent on the flood of 1924. The Cauvery Dam was damaged to the extent of 800 feet. In regard to the rest of the Dam, while it is admitted that there was damage here and there, the Madras Government states that it is not true that it was seriously damaged. The reconstruction of the portion of the Dam not seriously damaged, was merely with a view to provide against future floods.

(ii) *Clause* (*b*).—The statement that the Current Meter Section got widened by about 80 feet and remained in that condition to the end of the gauging season of 1926 is not correct. A statement of the width at the Gauging Section corresponding to 7·5 feet stage for the years 1923 to 1926 is appended (Appendix II). It is taken from the joint gauging reports and from that it will be apparent that there was no material change in the width.

(iii) *Clause* (*c*).—There were joint gaugings taken at the Current Meter Section in 1924. From that it will be evident that the average bed level at the Dam was the same as the crest level or higher and did not go below it. The depth of the scour as the effect of the high flood, was only 1·50 feet. The depth of the silt as shown by the summer section of 1924 was only 2·09 feet and the bed level did not go down by 3·85 feet as stated therein.

A joint section was taken at the Cauvery Dam in January 1925. Both the levels of the bed as it existed with shoaling on one side and silting on the other and of the masonry where it had been breached as observed by probing through sand, were recorded jointly by Mysore and Madras. The Mysore calculation seems to proceed on the assumption that both the shoal and the silt were not in existence and that the bed level arrived at by probing and by taking the crest of 236·24 feet at other places was the bed level. There is no basis for the theory or assumption that the shoal did not exist during periods of gauging in 1924.

(iv) *Clause* (*d*).—The Madras Government admits there had been breaches in a few places. The nearest breach was at Murungapet, five miles away from the Cauvery Dam and the next big breach was at Kilikudu, 16 miles from the Dam. The Murungapet breach was closed by the first week of September 1924 and the Kilikudu breach by the second week of December 1924.

20. *Paragraph* 14 *of Mysore statement.*—The statement that as a consequence of the above damages, discharges at the Cauvery Dam have abnormally increased gauge for gauge is denied. The increased discharges were merely due to the scouring of the sandy bed of the river, a natural result of the prolonged and high flood to be expected in the case of a river like the Cauvery. The increased discharges consequent

on the floods are no more than what they would have been, even if the Dam had remained intact and unbreached, provided the silt had scoured down to the crest level of the Dam. The discharges are in no way affected by the breaches in the Dam.

21. *Paragraph* 15 *of Mysore statement.*—The Madras Government denies that there is any change in the regime of the river. It is not understood in what sense the Mysore Government has used the term "regime." In the case of a river with a large width, with a sandy bed and which is subject to heavy floods and to variations of discharge and consequent erosions and silting up at different seasons of the year, the expression "old regime" conveys no special significance.

22. *Paragraph* 16 *of Mysore statement.*—The Madras Government denies the allegations therein that the agreement of 1924 proceeded on the assumption of the continued existence of the control works, the river bed and the banks in the same state in which they had been for a long number of years. They further deny that there was any implied condition or warranty to the effect stated in paragraph 16 of the Mysore statement. Changes and variations were and must necessarily have been in the contemplation of the parties. The Madras Government states that if a variation by way of silting up which might operate to the disadvantage of Madras could be said to be in the contemplation of the parties, a scouring which might operate to the disadvantage of Mysore, could equally be said to be in their contemplation.

Taking the figures for 7·5 feet gauge the average arrived at on the basis of the ten years will not be more than 7·71 per cent above the three years' average (1917—1919) and not more than 10·74 per cent above the $7\frac{1}{2}$ years' average.

23. *Paragraph* 17 *of Mysore statement.*—The Madras Government denies that the foundation and the basis of this agreement have disappeared or that the purpose and object of the agreement has become impossible. No question of impossibility of performance can possibly arise inasmuch as there is no difficulty in applying the terms of clause 8 to the conditions of 1924, 1925 and 1926 and inasmuch as under the terms of the agreement Mysore is not supplying any quantity of water to Madras and its only duty is to permit Madras to have the gauge readings and the discharges when the natural flow permits it during any particular days in any month.

24. *Paragraph* 18 *of Mysore statement.*—Even at the time of the construction of the Krishnarajasagara it was realized by both the parties that the securing to Madras of its rights of water might involve Mysore not being able to cultivate the full extent of land referred to in this paragraph. In entering into the agreement of 1924 and in launching upon the construction of the Krishnarajasagara, Mysore took the risk of their not being able to cultivate the full extent of land mentioned in this paragraph. Far from there being any kind of obligation on the part of Madras to secure to Mysore the right to cultivate any definite extent, the rights of Mysore under the agreement are expressly subject to a minimum flow being secured to Madras. In the case of Madras its extensive and existing rights had to be protected, while in the case of Mysore, its projected scheme was only for prospective irrigation.

25. The main object of Madras in entering into the agreement and what was expressly in the common contemplation of both the parties, was that Madras must be in a position to secure the necessary command by the agreement ensuring to Madras the requisite limit gauges. As a result of even the average standard for the ten years under clause 8 being adopted, Madras will secure much less than the limit gauges stipulated for, whereas if the seven and a half years' average is adopted, Madras would be a still greater sufferer.

OOTACAMUND,
28th May 1929.

APPENDIX I.

Statement showing reduced mean bed levels of the river at Cauvery Dam (as taken from the annual river charts) and depth of silt over Cauvery Dam crest 236·24.

Years.		Average depth of silt over the Dam crest 236·24.	Reduced mean bed levels of the river at Cauvery Dam.	Remarks.
1867	... ...	2·26	238·05	From old section.
1885–86	... ...	2·86	239·10	
1886–87	... ...	2·14	238·40	
1887–88	... ...	2·64	238·88	
1888–89	... ...	3·17	239·41	
1889–90	... ...	3·11	239·35	
1890–91	... ...	2·72	238·96	
1891–92	... ...	3·13	239·37	
1892–93	... ...	2·96	239·20	
1893–94	... ...	2·85	239·09	
1894–95	... ...	2·94	239·18	
1895–96	... ...	3·44	239·68	
1896–97	... ...	2·90	239·14	
1897–98	... ...	2·08	238·32	
1898–99	... ...	2·64	238·88	
	Total ...	39·58		
	Average ...	2·83		
1899–00	... ...	2·07	238·31	
1900–01	... ...	4·03	240·27	
1901–02	... ...	...	...	No chart map available.
1902–03	... ...	2·90	239·14	
1903–04	... ...	2·88	239·18	
1904–05	... ...	2·50	238·74	
1905–06	... ...	2·28	238·52	
1906–07	... ...	2·79	239·03	
1907–08	... ...	3·28	239·52	
1908–09	... ...	3·35	239·59	
1909–10	... ...	2·98	239·22	
1910–11	... ...	2·68	238·92	
	Total ...	25·64		
	Average ...	2·85		
1911–12	... ...	2·26	238·50	
1912–13	... ...	2·13	238·37	
1913–14	... ...	2·19	238·43	
1914–15	... ...	2·04	238·28	
1915–16	... ...	1·97	238·21	
1916–17	... ...	1·83	238·07	
1917–18	... ...	1·56	237·80	
1918–19	... ...	1·84	238·08	
1919–20	... ...	2·12	238·36	
1920–21	... ...	2·06	238·30	
1921–22	... ...	1·91	238·15	
1922–23	... ...	1·70	237·94	
1923–24	... ...	2·09	238·33	
Average of 1911–12 to 1923–24 is $\frac{25·7}{13}$ = 1·98				
1924–25	... ...	0·91	237·15	
1925–26	... ...	0·90	237·14	
1926–27	... ...	1·23	237·47	

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APPENDIX II.

Statement of the width at the Gauging Section corresponding to 7·5 feet stage for 1923—26.

CAUVERY DAM.

Widths at the Gauging Section for 7·5 feet gauge.

Year.	Water width.
	FEET.
1923	1,998
1924 (before floods)	2,006
1924 (after floods)	1,986
1925	2,018
1926	2,023

Letter from the Deputy Secretary to the Government of India in the Foreign and Political Department, to the Hon'ble the Resident in Mysore, dated the 8th November 1919, No. 4731-I-B.

I am directed to communicate, for the information of the Mysore Darbar, the decision at which His Majesty's Secretary of State for India has arrived upon the appeal preferred by the Government of Madras against the ratification by the Government of India of the arbitration award relating to the construction of the Krishnarajasagara reservoir on the Cauvery river in Mysore.

2. The Secretary of State holds that the Government of Madras were within their rights in appealing to him, firstly because the procedure prescribed in rule IV of the agreement of 1892 was varied in the Arbitration Proceedings and, secondly, because, while the agreement of 1892 was and is valid as between the Governments of Madras and Mysore, this does not relieve him from his general responsibility for intervening in any matter in which it seems to him that the public interest is threatened with injury, even if the possible injury would be consequent on action, taken under an award given, or purporting to be given, under rule IV.

3. He has further decided, for the reasons given in the memorandum annexed, that there is a *prima facie* case for entertaining the appeal of the Government of Madras against the ratification of the award on the ground of error.

4. The Secretary of State desires that these decisions should be communicated to the Mysore Darbar, in order that it may, if it so wishes, submit a representation against the cancellation of the ratification of the award. Should, however, the Darbar prefer to waive an appeal, it is open to it either to enter into negotiations with the Government of Madras with a view to a decision being reached out of Court, or to submit the main questions to arbitration by a new tribunal without further delay. Should the action last mentioned be taken, arbitrators should be appointed jointly by both Governments in accordance with the terms of rule IV of the agreement of 1892, and the Secretary of State has expressed his willingness to agree that, if satisfied that the proposed tribunal is suitably constituted, its decision shall not be subject to review by him.

ENCLOSURE

Memorandum.

1. The arbitrator has found on issue 2 (*b*) that Madras is entitled to a supply of 22,750 cusecs, equivalent to a gauge reading of 6·5 feet at the Cauvery Dam, as representing a full supply for its irrigation requirements. In order to ascertain the correctness or otherwise of this finding, it is necessary to examine whether the facts show that any portion of the water passed down the Cauvery in excess of the amount stated is or was in excess of the amount required for irrigation, and is or was in consequence run to waste.

2. It appears clear that so long as there was no control over the water entering the open heads of the Cauvery and Vennar branches, that is, in the period anterior to the construction of the Cauvery-Vennar Regulators in 1888 and the closing of the old Vennar channel in 1894, supplies in excess of irrigation requirements were unavoidably passed down those branches and wasted in whole or part.

3. In 1888 falling shutters were fixed on the crest of the Grand Anicut. These shutters fell automatically when the upstream level reached their top, and when once they had fallen it was very difficult and even dangerous to attempt to lift them until the depth of water passing over them had been considerably reduced. The immediate result of the shutters falling was to reduce the upstream level and consequently the supplies to the Cauvery and Vennar branches. Until, therefore, the nature of the flood had declared itself, it was desirable that the shutters should be kept standing as long as possible, by passing the flood water down the Cauvery and Vennar branches and so preventing the upstream rising to the level at which the shutters would automatically fail. So long as these conditions existed, that is, from 1888 to 1902, water during flood was thus constantly passed into the Cauvery and Vennar branches in excess of irrigation requirements.

4. After the remodelling of the Grand Anicut in 1902, complete control over the flood water was obtained; the supplies necessary for irrigation requirements could be maintained, and any excess passed over the Grand Anicut into the Coleroon. From the tables showing the actual working at the Grand Anicut from 1902 to 1911, it is clear that, without opening the Grand Anicut sluices, gauges of 7 feet at the Cauvery Dam (i.e., 26,500 cusecs) were constantly run when water was available in the river, and gauges of 7·5 feet (32,250 cusecs) were often run on special occasions. It is to be inferred either that the quantity of water connoted by a 7 feet

gauge at the Cauvery Dam was constantly required for irrigation, and that the supply connoted by a gauge of 7·5 feet was required on special occasions, or that, if a gauge of 6·5 feet (22,750 cusecs) was sufficient, the Madras Engineers must have deliberately and uselessly passed into the delta excesses of 3,750 cusecs in one case and 9,500 cusecs in the other, instead of passing them over the Grand Anicut into the Coleroon. The latter alternative cannot be accepted without convincing evidence, which has not been produced. Evidence to the contrary effect is supplied by the fact that rule 4 of the rules of 1905 for regulation at the Upper Anicut reads, "should water fall below 7 feet in the Cauvery Dam with the shutters closed, leakage should be prevented as far as possible by means of clay and straw." This clearly shows that up to a gauge of 7 feet on the Cauvery Dam supplies were required for irrigation.

5. When gauges between 7 feet and 7·5 feet were passed into the Delta they were probably useful for irrigation after periods of low gauges in order to send flushes down the delta branches. But it is not necessary to pursue this point, which goes beyond the claim submitted by the Madras Government to the arbitrator.

6. The conclusions are—

(1) that, before the remodelling in 1902, water was constantly passed into the Cauvery and Vennar branches in excess of irrigation requirements and was run to waste;

(2) that, after the remodelling in 1902, the water that was passed down the Cauvery in excess of 6·5 feet at the Cauvery Dam and up to 7 feet was required for irrigation;

(3) that, after the remodelling in 1902, the water that was passed down the Cauvery in excess of 7 feet at the Cauvery Dam and up to 7·5 feet was not always consumed for irrigation, but it probably facilitated the irrigation operations in the delta after the periods of low floods by enabling advantage to be taken of the flushes in the river.

These conclusions are at variance with the finding of the arbitrator.

7. The arbitrator appears to have been misled in part by the views stated in the Assessor's examination of the evidence on issue 2 (*b*) regarding the intention and effect of the opening of the undersluices at the Upper Anicut. In paragraphs 20 to 22 he gives calculations from which it is evident that he assumed that when, under the rules of 1882, the sluices in the Upper Anicut were opened for scour (as soon as the gauge at the Cauvery Dam reached, in ordinary conditions 6·5 feet, or after a defined period of scarcity, 7 feet) the gauge would steadily fall to 6 feet when the sluices would be closed. This assumption is not proved. The record of the actual gauge readings at the Cauvery Dam shows that after the opening of the sluices of the Upper Anicut the gauge frequently continued to rise or remained fairly steady. Moreover, paragraph 30 of Exhibit Ma 8, shows that the rules of 1882 for the working of the Upper Anicut sluices led generally in actual practice to a gauge reading of 7 feet being realized on the Cauvery Dam before the sluices were opened. In 1896 the rules were revised so as to raise the gauge limits to 7 and 8 feet.

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MYSORE-MADRAS CAUVERY ARBITRATION OF 1929

REPLY OF MYSORE TO THE COUNTER-STATEMENT OF MADRAS.

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MYSORE-MADRAS CAUVERY ARBITRATION OF 1929.

REPLY OF MYSORE TO THE COUNTER-STATEMENT OF MADRAS.

With reference to paragraph 1, Mysore says that its contention that the provisions in clauses 7 and 8 of the agreement of 1924 to take the ten years' average curve for determining the limit quantities to be given to Madras have become vitiated, does not involve the result which Madras contends for. The arbitral tribunal has perfect jurisdiction to hold that on a true construction of the agreement the vitiated gaugings have to be excluded and the gaugings that are not so vitiated should alone be taken into account.

Mysore denies that the contention of Madras that the whole contract falls to the ground is sound.

Mysore denies that by reason of its being a party to the present reference, it is not open to it to contend that the agreement so far as the method of ascertaining the limit quantities to be given to Madras for the purpose of the impounding formula is concerned, has become incapable of performance. Moreover the averments in paragraphs 16 and 17 of the statement of the case by Mysore are not new, but have been clearly set out as the foundation of its contention in the correspondence that preceded the constitution of the arbitral tribunal and it is with this knowledge that both the Governments brought the present tribunal into existence and invested it with jurisdiction under the wide and liberal terms of clause XV of the agreement, for the very purpose of determining the points of difference and settling the difficulty that had arisen. Madras cannot now turn round and say that the jurisdiction of the tribunal so constituted should be circumscribed in the manner contended for.

2. With reference to paragraph 2, Mysore says that clauses 7 and 8 stand together and are merely transitory provisions for the purpose of fixing the limit quantities to be given to Madras for the purpose of the impounding formula under clause 10 which is the essential working clause. After the experimental period of ten years, clauses 7 and 8 exhaust themselves and have no further operation. It is a misapprehension to say that if the method contained in clause 8 cannot be carried out, the supposed rights of Madras under clause 7 will continue intact as alleged. There are no rights created by clause 7 and that clause cannot be given operation after the expiry of the experimental period of ten years for which period alone it is to function according to the express terms of the contract.

3. With reference to paragraph 3, Mysore says that the implied condition it contends for is not inconsistent with any express terms of the contract. Mysore also says that the gauging subsequent to the breaches of 1924 being vitiated by virtue of the implied condition, the tribunal has jurisdiction to hold that the vitiated gauging have to be excluded and that the gauging not so vitiated should be taken to fix the limit quantity to be given to Madras for the purpose of the impounding formula in rule 10, in accordance with the intentions of parties.

4. With reference to paragraph 4, Mysore says that the result that would be reached by the findings thus arrived at, would be fair and equitable to the parties under all the circumstances of the case.

5. With reference to paragraphs 5, 6 and 7 Mysore will rely upon the various relevant documents for a proper appreciation of the disputes between the parties that led to the arbitration of 1914, the terms of the award and what happened subsequent to the award and the negotiations that resulted in the agreement of 1924. It is incorrect to say that the Secretary of State vacated the award of the Arbitrator. All that he did was to admit the appeal of Madras and to call upon Mysore to respond. Mysore does not admit the various allegations in the said paragraph in so far as they are inconsistent with or contrary to what appears in the proceedings.

6. With reference to paragraph 8, Mysore says that the limit flow to be given to Madras was to be determined by the average curve for ten years under clauses 7 and 8 under the then existing conditions, the continued existence of which was the common postulate between the parties.

7. With reference to paragraph 9, Mysore says that the ten years contemplated in rules 7 and 8 were ten years under normal conditions.

8. With reference to paragraph 10, Mysore says that the only risk that the parties contemplated in working out clauses 7 and 8 was the operation of normal and seasonal changes. What actually occurred and which altered the basis and foundation of the agreement was altogether beyond the contemplation of the parties.

9. With reference to paragraph 12, Mysore says that the lands above the Srirangam Island do not come into calculation. As regards the 27,000 acres of French Territory and the lands irrigated by the Lower Coleroon, they were expressly taken into account in fixing the quantities to satisfy the prescriptive rights of Madras.

10. With reference to paragraph 13, Mysore says that the Cauvery Dam was and is an important controlling work as is shown by the action of Madras in reconstructing the dam after the breaches of 1924. Mysore says there is no warrant for the assertion of Madras that the crest level of the dam when it was constructed was on a level with the bed of the river. In Volume III, page 545, Mr. Hughes, the then Chief Engineer of Madras, has stated that it was not known what the level of the Cauvery bed was at the time the dam was constructed and that for a great many years past, it had been practically permanent in its average level of 3 feet below the Upper Anicut crest. In the face of this statement, it is difficult to see how Madras can make the assertion it now makes. Mysore does not admit the other allegations contained in that paragraph.

11. With reference to paragraph 14, Mysore says that it is clear from the repeated admissions in Madras documents that the river bed was constant ever since 1867 to 1923, subject only to slight seasonal variations. Madras in relying on the variations in the figures of 1899–1900, 1900–01, 1901–02 and 1902–03, is pressing into service the three years during which the Upper Anicut was being remodelled. In the arbitration proceedings of 1914 Madras had itself excluded this period in arriving at the average of 2·85 which they put forward as the average mean bed level of the river from 1867 to 1910–11. The attempted comparison between 1900–01 and 1902–03 is misleading. If the years during which the disturbing factor of the remodelling of the anicut was there, are excluded, and the years 1898–99 and 1902–03 when the bed levels were at 2·64 feet and 2·90 feet respectively, above the crest of the dam are compared, the fluctuations are not abnormal. Even taking the figures given in Appendix I (the accuracy of the figures between 1911 and 1924, Mysore is not in a position to admit) the fluctuations from 1867 to 1923–24 pre-breach, is within very narrow limits. The bed level stood at 2·26 feet in 1911–12 and at 2·09 feet in 1923–24, 1·98 feet being the average of 1911 to 1924 suddenly dropped to 0·91 foot after the breach. The levels taken jointly at the dam by both the parties during the years 1918 and 1923 are 2·28 feet and 2·26 feet respectively. In their appeal to the Government of India on the award of the Arbitrator, Madras says that it would be unreasonable to place stress on annual fluctuations. For the purpose of judging the real change in the regimen of the bed of the river after the breaches the depth of 2·85 feet should be taken into consideration.

12. With reference to paragraph 16, Mysore says that Madras in this paragraph has failed to appreciate the contention of Mysore. What Mysore says is that when the Technical Agreement was signed in 1921 the parties had before them the actual results of four years and when the agreement of 1924 was signed, they had before them the actual results of the gaugings of seven years and that the parties in the ordinary course expected the gaugings for the remaining three years of the experimental period to give about the same results. It is evident therefore that Madras signed the agreement on that expectation and was therefore evidently satisfied with what it expected to get.

13. Mysore denies that Madras is entitled to the limit gauges in clause 7. As already stated above, rules 7 and 8 are only transitory provisions. Mysore also denies that ten years or any particular number of years is the essence of the contract as alleged. All that the parties wanted was that the average for a sufficiently extended period should be used for fixing the limit quantities to be given to Madras.

14. With reference to paragraph 19 Mysore denies that the flood of 1924 was or could have been expected. None of the previous floods can be compared with the magnitude of the flood of 1924 and its effects. The Administration Reports of the Madras Government make it clear how very unexpected and unprecedented the floods of 1924 were and how they were altogether unprepared for such a contingency. It is misleading to compare the level of the earlier floods with the level of the flood of 1924, because of the extensive breaches of the banks and the dam and the other controlling works in 1924. The volume of the flood of 1924 was admittedly 485,000 cusecs against 369,000 cusecs of the previous maximum flood. The breaches resulting from previous floods, if any, were minor ones and had no effect on the river conditions as will appear in the chart annexed to the counter-statement of Madras. What is more relevant to the present controversy is that the floods of 1924 so very materially altered the state of things on the continued existence of which the parties had entered into the contract of 1924. Such a material change in the state of things that existed at the date of the contract could never have been in the contemplation of the parties.

15. Mysore controverts the denial of Madras that the floods of 1924 did not alter the physical configuration of the river and maintains that the changes brought about by those floods in the state of things existing at the time of the contract, were so material that in effect they made the river altogether a different one with reference to which the contract was made.

16. With reference to sub-clause (i) of paragraph 19, Mysore denies that it has exaggerated the damage done to the dam. Madras admits the destruction of 800 feet of the dam and that the rest of the dam was also damaged in places and that they reconstructed a major portion of it.

17. With reference to sub-clause (ii) of paragraph 19, Mysore says that the statement of the widths given by Madras refer only to the portion concerned in the discharge up to 7½ feet gauge. The width for this portion is apparently narrow immediately after floods because the whole river got deepened owing to the breaches and the river bed scoured, so the water was running over the deeply scoured bed. Hence the level of 7½ feet depth cannot be compared with the level corresponding to 7½ feet before the breaches. The 80 feet widening mentioned by Mysore refers to the width at the top portion of the bank. By the deepening of the channel, the water-way at 7½ feet got much larger than before the breaches.

18. With reference to sub-clause (iii) regarding the bed level, the matter has been sufficiently dealt with in paragraph 11 above. Regarding the gaugings taken at the Current Meter section in August 1924 when the floods subsided, the average bed level obtaining at that time cannot be considered as representing the levels at the time when the Cauvery Dam breached.

19. With regard to the second paragraph of sub-clause (iii) Mysore says that its calculation is based on correct principles and that the inference drawn from the probings of 1925 is also correct. The shoal and silt found in January 1925 could not have existed at the time of the breach.

20. With reference to sub-clause (iv) Mysore says that the magnitude of the breaches of the banks was such as to very materially affect the state of the bed of the river at the Cauvery Dam. Immense quantities of sand from the river bed below the dam were thrown on the wet lands to the extent of 2,500 acres and the river bed being thus much deepened the sand above the dam rushed as the dam having been breached there was nothing to hold it.

21. With reference to paragraph 20, Mysore affirms that the discharges in the Cauvery Dam were abnormal gauge for gauge consequent on the material alteration

in the water-way of the river. But for the damage done to the dam and the controlling works, the bed of the river would never have scoured down to the extent it did.

22. With reference to paragraph 22, Mysore affirms that the agreement proceeded on the assumption of the continued existence of the state of things at the time of the contract and that the implied condition must be read into the contract as contended for by them. Only normal silting and scouring with the state of things remaining the same was all that was in the contemplation of the parties.

23. The percentage comparison made in the latter part of paragraph 22 fails to bring out the extent of the real difference between the various averages compared. One cusec represents the irrigation of about 70 acres the duty as provided in the agreement. The average discharge at 7½ feet gauge for the year 1923 and the pre-breach period of 1924 was about 39,300 cusecs, while the discharge for that gauge for the period of 1924 after breach is 56,600 cusecs.

24. With reference to paragraph 23, Mysore reaffirms its contentions.

25. With reference to paragraph 24, Mysore says that the object and purpose of the agreement was :

(i) to give Madras what it is entitled to on its prescriptive rights for existing irrigation ;

(ii) to secure to Mysore cultivation of 125,000 acres under the Krishnarajasagara Scheme ; and

(iii) to divide the surplus as provided in the agreement.

26. With reference to paragraph 25, Mysore says that by the agreement of 1924 no command was guaranteed to Madras. Once the limit quantity of discharge to be given to Madras was finally fixed at the end of the experimental period of ten years, under normal conditions, Madras was to get that quantity whether they secured to them command or not. In the Arbitration Proceedings of 1914 Madras admitted that 6½ feet gauge would secure to Madras the necessary command. In their appeal to the Government of India and the Secretary of State, Madras said that they had no complaint to make against the award of 6½ feet on the ground of command.

The difference between the ten years' average and the 7½ years' average so far as command is concerned is only about 3 to 4 inches even according to the figures given by Madras.

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MYSORE-MADRAS CAUVERY ARBITRATION–1929

EXHIBITS FILED BY THE MYSORE DARBAR.

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LIST OF EXHIBITS FILED BY THE MYSORE DARBAR.

* A. Map of the Cauvery Basin.

* B. Mysore-Madras Cauvery Arbitration Proceedings (Volume II †—Pages 99 to 101—Paragraphs 13 to 23).

‡ C. Agreement of 1892 (Arbitration Proceedings—Volume II—Pages 20 to 28).

* D. Arbitration Proceedings (Volume I †—Page 5—Terms of Reference).

* D-1. Arbitration Proceedings (Volume I—Pages 89 and 90)—Finding of the Arbitrator on Second Term of Reference.

* D-2. Arbitration Proceedings (Volume I—Page 125—Paragraphs 187 and 188).

* D-3. Arbitration Proceedings (Page 143)—Arbitrator's award on Issue 2 (*b*).

* E. Arbitration Proceedings (Volume IV †—Page 5—Paragraphs 11 and 12).

* E-1. Arbitration Proceedings (Volume IV—Pages 8 and 9—Paragraph 24).

* E-2. Arbitration Proceedings (Volume IV—Page 13—Paragraph 35).

* E-3. Arbitration Proceedings (Volume IV—Pages 45 to 47 and 49—Paragraphs 75, 76 79 and 87).

§ F. Order of the Secretary of State for India—(Cauvery Reservoir Project—Part IV,—Page 41).

‖ G. Correspondence relating to Cauvery Arbitration Negotiations, 1920 to 1923 (Volume I †—Page 10—Letter, dated 3rd July 1920).

* G-1. Correspondence relating to Cauvery Arbitration Negotiations, 1920 to 1923 (Volume I—Page 19—Letter, dated 25th August 1920).

* G-2. Correspondence relating to Cauvery Arbitration Negotiations, 1920 to 1923 (Volume I—Page 22—Letter, dated the 29th August 1920).

* G-3. Correspondence relating to Cauvery Arbitration Negotiations, 1920 to 1923 (Volume I—Page 27—Paragraphs 21 and 22).

* G-4. Correspondence relating to Cauvery Arbitration Negotiations, 1920 to 1923 (Volume I—Pages 33 and 34—Letter, dated 20th September 1920).

* H. Agreement of 1924.

J. Note on the method of measurement at the Current Meter Section.

J-1. Note on discharge curve.

J-2. Note on the working of the impounding formula.

J-3. Note on working of Rule 11 of Annexure I to 1924 Agreement.

* K. Madras Administration Report of the Public Works Department, 1923-24—Part II—Irrigation—Chapter I—Paragraphs 28 to 32.

* K-1. Madras Administration Report of the Public Works Department, 1924-25—Part II—Irrigation—Chapter I—Paragraph 2.

* K-2. Madras Administration Report of the Public Works Department, 1924-25—Part II—Irrigation—Chapter I—Paragraphs 13 and 14.

L. Mysore Administration Report. Extract from—

* M. Mettur Reservoir Project—Volume I—Page 24.

N. Mysore Government Order of 1919.

N-1. Mysore Government Order of 1924.

* O. Arbitration Proceedings, 1914—Volume III †—Pages 541 to 544.

* P. Section of the Cauvery Dam.

* Q. Current Meter Sections (3).

* Q-1. Do. do.

* Q-2. Do. do.

* R. Mettur Reservoir Project—Volume V—Page 33.

* S. Map of the Srirangam Island.

* T. Chart showing discharges from 1917 to 1926.

U. Krishnarajasagara Working Tables with limit discharges based on the average of 7 years.

U-1. Krishnarajasagara Working Tables with limit discharges based on the average of 10 years.

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* Not printed in the volume.
† The reference is to the Mysore print of the volumes.
‡ Printed separately in G.O. No. 162 I., dated 18th February 1892.
§ Printed as an annexure to the Madras counter-statement.
‖ The reference is to the Mysore print of the correspondence.

* V. Correspondence subsequent to 1924 (Page 1—Letter, dated 1st December 1924, from Madras to Mysore).

* V-1. Correspondence subsequent to 1924—(Pages 4 to 6—Letter, dated 2nd October 1925, from Madras to Mysore).

† W. Cauvery Reservoir Project—Part IV ‡—Letter, dated the 27th February 1913, from Madras to the Hon'ble the Resident in Mysore.

† X. Sketch showing the flow of water before, during and after breach.

Y. Note on the effect of a high flood on the movement of sand.

§ Z. Notice of Mysore to admit facts.

§ Z-1. Madras reply to Mysore demand for admissions.

† AA. Discharge curve.

N.B.—Parties are at liberty to refer to any portion of the printed volumes filed above.

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* Printed separately. † Not printed.

‡ The reference is to the Mysore print of the volumes. § These have been printed separately in the volume.

EXHIBITS FILED BY THE MYSORE DARBAR.

A. Map of the Cauvery Basin. (Not printed.)

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D. Arbitration Proceedings. (Volume I—Page 5—Terms of Reference.) (Printed separately.)

D-1. Arbitration Proceedings. (Volume I—Pages 89 and 90.) Finding of the Arbitrator on Second Term of Reference. (Printed separately.)

D-2. Arbitration Proceedings. (Volume I—Page 125—(Paragraphs 187 and 188.) (Printed separately.)

D-3. Arbitration Proceedings. (Page 143.) Arbitrator's award on Issue 2 (*b*). (Printed separately.)

E. Arbitration Proceedings. (Volume IV—Page 5—Paragraphs 11 and 12.) (Printed separately.)

E-1. Arbitration Proceedings. (Pages 8 and 9—Paragraph 24.) (Printed separately.)

E-2. Arbitration Proceedings. (Page 13—Paragraph 35.) (Printed separately.)

E-3. Arbitration Proceedings. (Pages 45 to 47 and 49—Paragraphs 75, 76, 79 and 87.) (Printed separately.)

F. Order of the Secretary of State for India. (Cauvery Reservoir Project—Part IV—Page 41.) (Printed as an annexure to the Madras counter-statement.)

G. Correspondence relating to Cauvery Arbitration Negotiations, 1920 to 1923. (Volume I—Page 10—Letter, dated 3rd July 1920.) (Printed separately.)

G-1. Correspondence relating to Cauvery Arbitration Negotiations, 1920 to 1923. (Page 19—Letter, dated 25th August 1920.) (Printed separately.)

G-2. Correspondence relating to Cauvery Arbitration Negotiations, 1920 to 1923. (Page 22—Letter, dated the 29th August 1920.) (Printed separately).

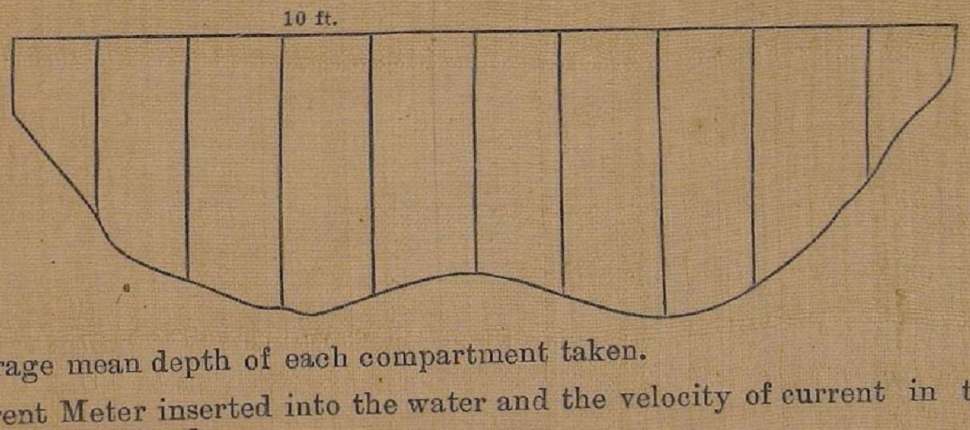
G-3. Correspondence relating to Cauvery Arbitration Negotiations, 1920–23. (Volume I—Page 27—Paragraphs 21 and 22.) (Printed separately.)

G-4. Correspondence relating to Cauvery Arbitration, Negotiations 1920–23. (Pages 33 and 34—Letter, dated 20th September 1920.) (Printed separately.)

H. Agreement of 1924. (Printed separately.)

MYSORE EXHIBIT J.

Note on the method of measuring at the Current Meter section.



Average mean depth of each compartment taken.

Current Meter inserted into the water and the velocity of current in the compartment is ascertained.

Mean depth × 10 gives the area of the compartment in square feet.

The area multiplied by the velocity of the current gives the rate of the flow in the section in cubic feet per second.

This calculation is taken for all the sections. The totals of these give the rate of discharge for the whole river in cubic feet per second.

At the time of commencing the above operation, the reading on the North Gauge is noted. It is also noted at the end of the operation. The mean of the above two readings is taken as the gauge height corresponding to the discharge.

MYSORE EXHIBIT J-1.

Note on Discharge Curve.

The result, that is, the discharge in cusecs arrived at by the gauging on each day is charted on a graph paper as corresponding to the particular height for which it was the result. This is done from day to day for each height at the time the gauging was taken throughout the gauging season.

Then a mean line is drawn through all the points for each height that may have been recorded.

This is called the average discharge curve for the year. The discharge for the particular year connoted by any particular height mentioned in rule 7 is deduced from the average discharge curve by finding on the chart the number of cusecs corresponding to that height in the graph.

The average discharge curve for the ten years is drawn by taking the mean curve arrived at from the ten years' curves.

MYSORE EXHIBIT J-2.

Note on the working of the Impounding Formula.

After 'C' is deduced by the average of the gaugings under Rules 7 and 8 of the Rules of Regulation, it becomes a permanent factor to be used for the purpose of finding the quantity of water impoundable in the Krishnarajasagara by applying the formula mentioned in Rule 10 which is as follows:—

$$I = \frac{Kn}{P} - C$$

Kn represents the inflow into the Krishnarajasagara which is to be calculated and measured as stated in Rule 10. From the inflow of the Krishnarajasagara which is Kn, the quantity which that flow would amount to if allowed to pass on to the Cauvery Dam, is derived. This is done by dividing Kn by ·625, in the south-west monsoon and ·300 in the north-east monsoon. From this quantity, which represents what the flow from the Krishnarajasagara would amount to at the Cauvery Dam, is deducted C, which is the quantity due to Madras in any particular month as representing the gauges stated in Rule 7.

The effect of the formula is as follows.

Up to a certain minimum limit of the inflow into the Krishnarajasagara all the flow in the river has to be let down and Mysore cannot impound any quantity. When the inflow goes higher than that limit, Mysore can impound the quantity as ascertained from the formula. As the inflow goes on increasing, the quantity impoundable increases and the quantity of discharge from the Krishnarajasagara goes on diminishing till a second stage is reached when nothing is discharged and the whole inflow is impounded. The idea is that when there are higher flows into the Krishnarajasagara, the anticipated flows from the other rivers and the catchment area down below will also bring in larger quantities of water and would make up by themselves the limit flow due to Madras, e.g.—

Say that the limit flow, viz., C is 30,000 cusecs. Mysore cannot impound till the inflow reaches 18,750 cusecs. When the inflow goes on higher, Mysore can go on impounding till when the inflow reaches 50,000 cusecs and after, Mysore can impound the whole of it without allowing any quantity to flow.

By reason of the working of this formula for a period of 10 years, if it is found that P, viz., ·625 during the south-west monsoon and ·300 during the north-east monsoon, does not bring up the amount due to Madras within a margin of 5 per cent, the same is to be raised so as to bring it up to that amount. The process is mentioned in Rule 11.

MYSORE EXHIBIT J-3.

Note on working of Rule 11 *of Annexure I to the* 1924 *agreement.*

A doubt was raised by the Arbitrator yesterday (1–6–29) as to how Madras would be ensured their limit supplies after the averages were fixed under Rule 8, if no gauging were done at the Cauvery Dam after the period prescribed in the Rule

and our counsel wanted a note on this. The rules contemplate no such gauging as that would put a bar on Madras undertaking any works across the Cauvery and its tributaries in their territory. The rules of 1921 were devised with the express purpose of removing the restriction which had been imposed in the award rules in a somewhat indirect manner as explained in another note. When once C and P of the formula $I = \frac{Kn}{P} - C$ are fixed, the presumption is that if Kn—I is passed down from the Krishnarajasagara, Madras would get whatever quantity is due to them according to the rules. In order, however, to guard against any appreciable loss to them, the actual flow that would be realized under the rules for the term of years prescribed in rule 8, is examined under rule 11 for every day of the impounding season of each year, with the minimum proportion factors of ·625 and ·300 for P in the above formula. If such examination shows that a deficit is caused above 5 per cent in more than one "impounding period" (which term is defined in the rules) then the proportion factor has to be enhanced suitably so as to limit the deficit to one period. When the proportion factors are so fixed, they are to be in force during the currency of the agreement. With such enhanced proportions it is assumed that no loss would be caused to Madras as the meteorological cycle of years are assumed to repeat themselves generally. If, in the cycle of examination years, the losses are made good, it is understood that there would be no loss in future cycles.

The formula of impounding is based on the principle of *forecasting the flow at the Cauvery Dam* from the actually *measured inflow at Krishnarajasagara* every day. This forecasting is done by multiplying the Krishnarajasagara inflow by the inverse of the prescribed proportion factor. For example, the proportion prescribed for the south-west monsoon period (June to September) is 0·625. If the inflow at the Krishnarajasagara is, say 20,000 on any day, the corresponding flow at Cauvery Dam would be $\frac{20,000}{0{\cdot}625} = 32,000$ cusecs *a few days hence.* (This latter period depends on the time taken for transmission in the river course from the Krishnarajasagara to Cauvery Dam and it is assumed in the 1921 rules as four days.) If the inflow is 50,000 at the Krishnarajasagara, the corresponding flow at the Cauvery Dam would be 80,000 and so on.

The flow thus forecasted may be more or less than what the actual would have been, if the Krishnarajasagara inflow actually reached the Cauvery Dam. So far as Mysore is concerned, if the forecasting is not done and if they had to wait till the gauge at the Cauvery Dam exceeded the limit flow before they can begin impounding, the floods might come and go within the interval of four days taken in transmission and they would lose chances of impounding. Therefore, impounding in advance by forecasting the flow is essential for their interests. So far as Madras is concerned, if the system of impounding involved daily measurement at Cauvery Dam, there would be a bar on future developments in their territory. The system of impounding is therefore so devised as to remove these two disadvantages, while all reasonable safeguards are provided for ensuring the flow required by them.

The risk that Madras are incurring in the forecasted flow being realized fully or not, is removed by fixing the proportion factor high enough to keep down the losses within 5 per cent as explained above, by actual examination in a cycle of a definite term of years.

The actual method by which the minimum proportion factors of 0·625 and 0·300 were determined or how they are going to be increased, if necessary, under rule 11 need not be gone into.

MYSORE EXHIBIT K.

Madras Administration Report of the Public Works Department, 1923-24. Part II—Irrigation—Chapter I—Paragraphs 28 to 32. (Printed separately.)

MYSORE EXHIBIT K-1.

Madras Administration Report of the Public Works Department, 1924-25. Part II.—Irrigation—Chapter I—Paragraph 2. (Printed separately.)

MYSORE EXHIBIT K-2.

Madras Administration Report of the Public Works Department, 1924-25. Part II.—Irrigation—Chapter I—Paragraphs 13 and 14. (Not printed.)

MYSORE EXHIBIT L.

Extract from the report on the Adminitration of Mysore for the year 1924-25 (*ending* 30*th June* 1925).

V. Important events and administrative measures.

* * * * *

18. *Floods.*—The abnormal and heavy rainfall in the Malnad parts of the State and the adjoining British territory during the months of July and August 1924, brought about unusual floods, higher than those recorded in the previous year, in the Cauvery, Kabini, Thungabhadra, Hemavathi and Yagachi rivers, causing serious loss of property, land-slips, damage to bridges, railway lines, roads and cultivable lands, interruption of communications and the submersion of part or whole of several riverside villages and towns like Yedatore, T. Narsipur, Seringapatam, Shimoga and Harihar. About 655 villages were wholly or partly submerged, about 6,070 houses were damaged and over 77 tanks as also a number of channels were breached or otherwise damaged. In the Mysore district the floods in the several rivers commenced about 15th July 1924 and occurred twice within a week of each other and reached an unprecedented level on the 25th idem. The rainfall was heaviest in the month of July 1924 in the Malnad districts and on a single day 16·53 inches of rain fell at Agumbe. The estimated value of the property lost was about Rs. 5,50,334. An extent of about 15,744 acres was affected by the floods, and the loss of crops and the damages caused to lands were estimated at Rs. 9,05,593. Excepting Shimoga, for which detailed figures were not available, an extent of 231 acres 5 guntas was permanently rendered unfit for cultivation. Four thousand nine hundred and thirty two acres 34 guntas, though damaged, could be repaired at some cost, while the crop grown on an area of 7,587 acres was washed away or otherwise damaged. Much of this extent was, however, resown. There was no loss of life, excepting the solitary instance of the death of a boy due to the collapse of a house in the Manjarabad taluk on account of the heavy downpour. It is stated that the people had not even time in some places to remove their household effects and vacate their houses before water rushed in, while in other places the people were duly warned beforehand, of the coming of floods. The people of Thirumukudlu sought shelter on the top of the temple for three days. Distress was acute and some of the villagers had lost all their property and immediate help was needed . .

Krishnarajasagara and allied works.

97. The sanction programme for the year under report was to raise the weir at the permanent weir site to 106 feet above the riverbed and the remaining part of the dam together with the river gap portion, which was at 80 feet to 122 feet, so that the floods for 1925-26 onwards may pass through the permanent waste weir valley instead of over the dam in the centre and the design and arrangements being on the assumption that the highest flood discharge to be passed in the river was 250,000 cusecs. But as during the year, the Cauvery brought unprecedented floods of an intensity of about 290,000 cusecs for beyond those known within living memory, the design of the surplussing arrangements had to be revised to suit the increased expectations. Accordingly, to consider the design of the surplussing arrangements and also certain other points relating to the works, a committee consisting of Sir Frederick St. John Gebbie, Consulting Engineer to the Government of India, as Chairman and Messrs. Rajasabhabhushana Karpur Srinivasa Rao and Raja Silpavisarada Rao Bahadur B. Subba Rao as Members, was formed to advise Government in the matter. In accordance with the recommendations of the Committee a revised programme of work for the completion of the dam to 130 feet with weir at 106 feet during the four years from 1925-26 was drawn up and submitted to Government, the expenditure to be incurred immediately on the dam works being about 22 lakhs . . . Work progressed on the Chamaraja right bank channel and Mandagere channel and the unprecedented floods in July and August 1924 caused heavy damage to works on the Cauvery valley and expenditure incurred on repairing these damages amounted to Rs. 2,53,873 . . .

XIII. Electrical Department.

Finance.—104. . . . and the complete stoppage of the power supply for 48 hours on account of high floods in July 1924 the loss on this account being calculable at Rs. 24,000 on the basis of the average daily earnings.

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MYSORE EXHIBIT M.

Mettur Reservoir Project—Volume I—Page 24. (Printed separately.)

MYSORE EXHIBIT N.

Constitution of a Committee for advising on the question of a suitable design for the waste weir of the Krishnarajasagara Reservoir.

No. P.W. 420-27—K.S.S. 1850-57, dated 12th February 1919.

PROCEEDINGS OF THE GOVERNMENT OF HIS HIGHNESS THE MAHARAJA OF MYSORE.

PUBLIC WORKS DEPARTMENT.

Read—

Public Works Secretary's Note No. D. 694, dated the 23rd October 1918, forwarding, for the consideration of Government, letter No. 751—G., dated the 9th October 1918, from the Chief Engineer on Special Duty, Cauvery Valley Irrigation, submitting a detailed memorandum on the design of the waste weir for the second stage of the Krishnarajasagara Dam.

Order No. P.W. 420-27—K.S.S. 1850-57, dated 12th February 1919.

The question of a suitable design for the waste weir of the Krishnarajasagara dam has been under the consideration of Government for some time. On account of the somewhat complex nature of the problem and the magnitude of interests involved, both within and outside the State, the Government have thought it desirable to constitute a committee of experienced Engineers for advising them as to the best design to be adopted.

2. They are accordingly pleased to direct that a committee composed of the following members be constituted for the purpose :—

President.—Sir M. Nethersole, *Kt.*, C.S.I., late Inspector-General of Irrigation in India and now Chief Hydraulic Engineer, Andra Valley Power Supply Co., Bombay.

Members.—The Hon'ble Mr. W. J. J. Howley, A.M.I.C.E., Chief Engineer for Irrigation, Madras.

" Rajasabhabhushana C. T. Dalal, Esq., L.C.E., Special Superintending Engineer, Oosman Saugara Project, Hyderabad.

" Rajasabhabhushana Karpur Shrinivas Rao, Esq., B.SC., L.C.E., Retired Chief Engineer of Mysore.

" Rajasabhabhushana Rao Bahadur K. Krishnaiengar, Esq., B.A., L.C.E., Chief Engineer on Special Duty, Cauvery Valley Irrigation.

Secretary.—Mr. M. G. Rangaiya, B.A., B.E., Executive Engineer, Mysore, Public Works Department.

3. The terms of reference to the committee will be as noted below :—

(1) What limiting velocities may safely be allowed in the low level scouring sluices without danger of scour to the ashlar work in the bed and sides of the vents and whether any great harm is apprehended if these sluices are worked for a few hours when the maximum calculated flood occurs once in 30 or 40 years?

(2) What arrangements are best suited to dispose of the maximum flood from the catchment area, having due regard to the discharging capacity of the several sluices already built, or proposed to be built, in the body of the dam?

(3) To what extent should the flood moderating capacity of the reservoir be taken account of, in fixing the discharging capacity of the weir?

(4) What should be the nature, disposition, number and dimensions of the weir sluices?

(5) What should be the exact nature of the protective works needed to prevent retrogression of levels in the waste weir channel and the eventual damage to the weir body wall?

(6) Any other points which may arise, or be raised, incidentally.

4. A report embodying the recommendations of the Committee on the above terms of reference will be submitted to Government before the 31st March 1919.

S. CADAMBI,
Secy. to Govt., P.W. Dept.

To—Sir M. Nethersole, *Kt.*, C.S.I., Late Inspector-General of Irrigation, now Chief Hydraulic Engineer, Andra Valley Power Supply Co., Bombay.
The Hon'ble Mr. W. J. J. Howley, Chief Engineer for Irrigation, Madras.
Rajasabhabhushana C. T. Dalal, Esq., L.C.E., Special Superintending Engineer, Oosman Saugara Project, Hyderabad.
Rajasabhabhushana Karpur Shrinivas Rao, Esq., B.SC., L.C.E., Retired Chief Engineer of Mysore.
S. Cadambai, Esq., B.A., L.C.E., Chief Engineer of Mysore.
Rajasabhabhushana Rao Bahadur K. Krishnaiengar, Esq., B.A., L.C.E., Chief Engineer on Special Duty, Cauvery Valley Irrigation.
M. N. Krishna Rao, Esq., B.A., Comptroller of Mysore, Bangalore.
Mr. M. G. Rangaiya, B.A., B.E., Executive Engineer, Mysore Public Works Department.

SHORT NOTES BY THE CHIEF ENGINEER ON SPECIAL DUTY, CAUVERY VALLEY IRRIGATION, ON THE TERMS OF REFERENCE TO THE COMMITTEE.

I. *Safe maximum velocities that may be allowed through the scouring sluices.*—The Resident Engineer, Assouan Dam, stated that velocities approaching 40 feet per second are frequently allowed while a velocity of 50 feet is rarely permitted. In the Madras Mettur Reservoir Project a velocity of 30 feet per second has been allowed for sluices in the dam (vide Annexure B and page 159, Volume I, Mettur Project).

Following the example of Assouan Dam we may, during very extraordinary floods which are of short duration and which occur once in 30 or 40 years, permit a velocity of 50 feet per second equivalent to a head of 100 feet over the centre and 106 over the sill of our sluices, i.e., up to 106 + 12 or 118 feet above bed of river which is the M.W.L. fixed for Krishnarajasagara.

At ordinary times.—A velocity of 40 feet may be allowed. This means a head of 64 feet over the centre of sluice or + 82 feet above bed.

II. *Maximum flood discharge from the catchment at Krishnarajasagara and the best way of disposing of it.*—The estimated maximum flood discharge in the river is 250,000 c.f.s. In the Madras Mettur Project, the same quantity has been calculated at Bhavani 174 miles lower down, but this is certainly an under-estimate. (Vide page 23, Volume I, Mettur Project.) The maximum flood calculations for Krishnarajasagara have been verified in several ways and the estimate of 250,000 cusecs may be taken as very close to the actual as the floods of 1882 and 1911 have shown. Such a flood occurs once in 30 or 40 years. An uncommon flood is 200,000 c.f.s. once in 14 or 15 years, while the most usual flood every five years ranges between 120,000 and 150,000 c.f.s. (vide Annexure C).

The maximum flood being assumed at 250,000 cusecs, we may allow 50,000 cusecs, for the flood moderating capacity of the reservoir as shown under the next term of reference. We have to provide for the balance of 200,000 being passed (1) through or over the weir and (2) through the sluices in the dam.

The sluices that may be operated during such floods and their discharging capacities with water at + 118 are noted below:—

	Discharging capacity.
1. High level scouring sluices at + 50	10,563 cusecs.
2. Low level irrigation sluices at + 40	2,674 ,,
3. Low level scouring sluices at + 12	28,800 ,,
4. Turbine sluices at + 53	3,827 ,,
5. Supply from high level irrigation sluice at + 60	2,200 ,,
Total ...	48,064 ,,

It is considered undesirable to utilize the high level irrigation sluices for surplussing floods on account of costly drops and regulators needed, of the necessity of a very wide discharge channel from the scouring sluices to take up the extra discharge let down from the high level irrigation sluices if used as surplus sluices and of its interference with the lay-out of the proposed power station on the north bank.

The balance to be provided for through and over the waste weir is 152,000 cusecs.

III *Flood moderating capacity of the reservoir.*—This has been calculated assuming 250,000 c.f.s. as the maximum flood discharge starting from + 110. To reach the maximum full supply level of + 118, floods will take 25 hours. Such a long duration of maximum floods never occurs, the longest recorded period of such being 12 hours. When water reaches the level of + 118, the reservoir will absorb at the rate of about 50,000 cusecs, the balance being discharged by the waste weir sluices. (Vide Annexure D.)

IV. *The number and nature of sluices necessary to discharge the maximum flood*—

A. If the flood moderating capacity and discharge from dam sluices is not to be considered, we require:—

	Discharge.
25 sluices at + 80 8′ × 15′	83,100 cusecs
49 sluices at + 90 8′ × 15′	133,182 ,,
35 sluices at + 110 10′ × 8′	24,570 ,,
3 scouring sluices at + 50 6′ × 15′	10,503 ,,
Total ...	251,355 ,,

(Vide alternative A on the longitudinal section of weir.)

B. In case the flood moderating capacity to the extent of 50,000 cusecs is to be allowed for, but the dam sluices are not to be worked under such high heads, the arrangement suggested is—

25 sluices at + 80 8′ × 15′	83,100 cusecs
31 sluices at + 90 8′ × 15′	84,258 ,,
35 sluices at + 110 10′ × 8′	24,570 ,,
	191,928 ,,
3 high level scouring sluices	10,503 ,,
	202,431 ,,

(Vide alternative B on the above plan.)

C. In case both the flood moderating capacity of the reservoir and the discharge through the sluices in the body of the dam are taken into account, we may have—

	Discharge.
25 sluices at + 80 8′ × 15′	83,100 cusecs
18 sluices at + 90 8′ × 15′ commencing from C.S. 156 and ending at C.S. 160	48,924 ,,
35 automatic sluices at + 110 10′ × 8′	24,570 ,,
	156,594 ,,

against only 152,000 to be dealt with.

(Vide paragraph 2 supra.)

The discharge in this case will be divided between the two valleys and the necessity of clearance of the high ground between C.S. 145 and 165 will be obviated as also the construction of costly groyne wall to distribute the floods evenly between the two valleys.

V. *Protective works.*—These range themselves under six heads—

(1) Construction of ogees from the lips of the several sets of sluices and dropping the discharge to the ruling level of the river bed. This need not be considered as it means a duplication of our dam, with very deep rock excavations.

(2) Construction for the present of two deeply founded curtain walls across the two valleys, and watching how the bed of surplus channel above and below may be affected by the floods. The crest of this wall may be at + 65 and the bottom at + 40·00 the level at our low level channel crossing. Further work may be designed after watching the action of floods—*vide* block plan of weir site in Annexure F.

Under existing circumstances, it is possible to ascertain by actual test what the action of the floods will be on the surplus channel bed.

We may raise the river gap to + 80 the level for the first stage of the dam and provide a bye-wash at + 80 for 500 feet between C.S. 135 — 145 on the South Bank. We may pass the floods of 1920 over the river gap as well as over the bye-wash and see how the floods affect the ground in rear and what the nature of rock is in the surplus channel and then decide the levels of our curtain wall, etc.

(3) A number of equidistant grade walls deeply founded so as to form natural water cushions between them. The effect of floods on the wide unprotected spaces between the grade walls is uncertain and this design will be quite a make-shift requiring heavy work afterwards which, once the river gap is filled in, we shall not be able to complete in the short space of four or five months of the cold season.

(Vide plan in Annexure F.)

(4) Ultimate, solid and permanent structures may take the form of water cushions terminated by an ogee.

(5) Water cushions, apron and ogee.

(6) Continuous apron sufficiently thick and constructed in mortar with suitable binding and retaining walls.

Types of these designs are plotted on a few cross sections of the surplus channel. Which of these types may be eventually adopted has to be settled. Then detailed estimates may be prepared with due reference to the actual foundation levels of the weir wall. As this is not yet definitely known, estimates and plans that may be now prepared on conventional foundation will be of little use for accurate guidance in execution—vide plans in Annexure E.

In view of the difficulties of deciding upon the exact nature of protective works and the probability of our having to wait for a long period before permanent remedies could be effected and the consequent trouble and anxiety involved at the present site of weir, attempts were made to find out whether other suitable saddles distant from the ends of our dam could be secured for the diversion of the surplus along the ridges enclosing the reservoir. There is only one such saddle close to the Inspection Lodge at the point M where the approach road bifurcates and where the shandy or market place is now held. Longitudinal and cross sections of the saddle show that a diversion cut here will be rather a very costly affair and may cost a crore of rupees. The cost could have been reduced somewhat if the crest of dam had been placed 20 or 25 feet above the present level, but it is now out of question to attempt the diversion here—vide Section of Saddle M.

VI. (*a*) *Incidental matters arising from the above discussion.*—The one question that arises is the method of carrying the Right Bank low level sluice across the weir. Several alternative designs were worked out—

(1) Lifting dam.
(2) Aqueduct.
(3) Open cut beyond weir.
(4) „ and tunnelling across a ridge.

Considering the magnitude of the floods and the nature of fall and foundations in the surplus channel, alternative (3) is recommended as the best—vide plans in annexure G.

(*b*) The designs of weir that may be now settled will have to fit in with the further raising of the full supply level by 4 feet or + 122 as recommended by the Arbitrator to obviate Madras objections to the present size of the reservoir on the ground of failure of sufficient supply for irrigation in some years. Mysore have agreed to this raising by altering the crest levels of the weir. The dam has been designed strong enough to withstand the pressure due to a head of 124 feet. This will also enable the numbers of sluices being reduced, preferably those at + 90.

Letter dated 1st March 1919, from M. G. RANGAIYA, Esq., B.A., B.E., Secretary, Krishnarajasagara Waste Weir Committee, Bangalore, to S. CADAMBI, Esq., B.A., L.C.E., Secretary to the Government of Mysore, Public Works Department.

With reference to Government Order No. P. W. 420-27/K. S. S. 1850-57, dated the 12th February 1919, I am directed to submit herewith a report of the Proceedings of the Krishnarajasagara Waste Weir Committee, for the consideration and orders of Government.

2. The Committee commenced its sittings on the 24th February 1919 at Mysore. On the 25th idem, they inspected the waste weir site and the works. The final sitting was held on the 26th instant and the proceedings then terminated.

PROCEEDINGS OF THE KRISHNARAJASAGARA WASTE WEIR COMMITTEE.

Monday, Camp Mysore, dated the 24th February 1919.

PRESENT:

President.—Sir M. Nethersole, *Kt.*, C.S.I.

Members.—The Hon'ble Mr. W. J. J. Howley, A.M.I.C.E., Rajasabhabhushana Mr. C. T. Dalal, Rajasabhabhushana Mr. Karpur Shrinivasarao and Rajasabhabhushana Rao Bahadur K. Krishnaiengar.

Secretary.—Mr. M. G. Rangaiya.

The Proceedings commenced at 4 p.m. The President referred to the Government Order constituting the Committee which contained the terms of reference about which they were to advise the Durbar, and these were considered in the same order.

(1) "*What limiting velocities may safely be allowed in the low level scouring sluices without danger of scour to the ashlar work in the bed and sides of the vents and whether any great harm is apprehended if these sluices are worked for a few hours when the maximum calculated flood occurs once in* 30 *or* 40 *years.*"—The President stated his opinion that a velocity of 20 feet ordinarily and 30 feet occasionally might be allowed through these sluices and asked whether other members of the Committee agreed or would wish to vary these limits.

Mr. Krishnaiengar referred to a letter from the Resident Engineer, Assuan Dam, stating that velocities up to an average of 35 feet constantly and 40 feet occasionally were allowed there and that no trouble had been experienced since the year 1905. Sir M. Nethersole thought that the case was somewhat different as the Assuan Dam sluice vents were lined with cast-iron. It was brought to notice by the Secretary that, in a paper on the Assuan Dam read at the Institute of Civil Engineers, London, in the year 1913, the author of that paper when asked to give his opinion about the relative merits of cast iron and granite lining, stated that both were equally sound but that he would give a preference to granite, as in the event of undue wear the cast-iron lining repairs would be difficult. Messrs. Dalal and Howley thought that the reason that cast-iron was used was because labour to dress the granite was not available. These statements were verified by reference to the papers.

In this connexion Mr. Howley pointed out that the capacity of the sluices to pass the supplies due to Madras had also to be considered. Assuming the quantity tentatively fixed by the Arbitration Committee, namely, 14,219 cusecs, to be the maximum to be passed on to Madras, the corresponding velocity in the deep level sluice vents (8 of 6′ × 12′) would be about $\frac{14,219}{8 \times 6 \times 12} = 24{\cdot}7$ feet per second.

Considering that higher velocities were allowed in the Assuan Dam as stated above, it was generally agreed that a velocity of 25 feet might be safely allowed through the sluices for continuous working.

Mr. Dalal then asked whether it would be advisable to work these sluices under higher head when the reservoir was full. The President observed that he would not mind opening them under any condition provided the discharge was limited to 14,500 cusecs.

Mr. Howley remarked that he saw no harm if a velocity of 40 feet per second were allowed once in 30 or 40 years for a few hours during which the maximum flood would probably last.

Mr. Karpur Srinivas Rao stated that, as velocities up to 50 feet per second were permitted though rarely at the Assuan Dam, he thought there would be no objection to use the deep level sluices on such rare occasions.

The President summing up stated that in answer to the first term of reference it might be recorded that ordinarily the deep level sluices should be limited to a velocity of 25 feet per second necessary to give the discharge due to Madras, but that they might also be used when necessary for surplussing floods, limiting the discharge to 14,500 cusecs by partial opening of the sluices.

(2) *What arrangements are best suited to dispose of the maximum flood from the catchment area having due regard to the discharging capacity of the several sluices already builtor proposed to be built, in the body of the dam?*—Mr. Dalal observed that to decide this question it was first necessary to fix the maximum quantity of flood to be surplussed. The President remarked that he understood that the amount allowed for in the project 250,000 cusecs was sufficient. After some discussion it was agreed that this quantity might be assumed to be correct, although Mr. Dalal still expressed a doubt whether if the surplussing capacity of the sluices in the dam and the flood moderating capacity of the reservoir were both fully taken into account, it would be safe to limit the waste weir capacity to the balance. It was agreed that this would be considered in due course, but the President pointed out that there was a very large margin of safety already allowed in the free board of 6 feet over and above the calculated maximum full supply level.

As regards the quantity to be surplussed through the sluices already fixed in the dam, figures given in the subjoined table were unanimously agreed to as safe.

		Cusecs.
Sluices at	+ 12·00 level	14,500
Do.	+ 40·00 level	1,000
Do.	+ 53·00 level	10,500
Turbine sluices at	+ 50·00 level	3,000
Irrigation sluices at	+ 60·00 level	1,000
		30,000

In regard to the sluices to be fixed in the waste weir Mr. Krishnaiengar referred to the preliminary plans and sections prepared for the waste weir in which three alternative proposals A, B and C were shown. Proposal A made allowance for passing the entire flood of 250,000 cusecs through the weir sluices and gates. Proposal B allowed for a flood of 200,000 cusecs after taking account of flood absorbing capacity of the reservoir. Proposal C provided for only 150,000 cusecs after making allowance for the discharge through the sluices and of 50,000 for flood absorbing capacity. In all these alternative proposals the waste weir sluices were arranged at two different levels + 80 and + 90 with automatic gates at + 110. The discharges through these sluices with the reservoir full are given in the table below :—

	+ 80 level.		+ 90 level.		+ 110 level.		Total discharge.
	No.	Discharge.	No.	Discharge.	No.	Discharge.	
A	25	83,100	49	133,182	35	24,570	240,852
B	25	83,100	31	84,258	35	24,570	191,928
C	25	83,100	28	48,924	35	24,570	156,594

It was generally agreed after some discussion that both the flood absorbing capacity and the surplussing capacity of the sluices in the masonry of the dam might be taken into consideration in calculating the quantity to be provided for in the waste weir.

In case the alternative C was adopted, the flood would be disposed of as follows:—

Through the sluices in the dam	... ...	30,000 cusecs as shown above.
Through + 80 sluices	... ...	83,100
+ 90 sluices	... ...	49,000
+ 110 sluices	... ...	24,570
	Total ...	186,670

which leaves a balance of (250,000 — 186,670) = 63,330 cusecs to be absorbed in the reservoir.

The table attached (Appendix I) showing the flood absorbing capacity of the reservoir, indicates that this flow will raise the reservoir level by one foot in 5·6 hours and by two feet in 12 hours. It was generally agreed that the alternative C referred to above would serve to discharge the maximum flood safely.

3. *To what extent should the flood moderating capacity of the reservoir be taken account of in fixing the discharging capacity of the weir?*—This has been already considered under reference 2 and needs no further comment.

4. *What should be the nature, disposition, number and dimensions of the weir sluices?*—The President suggested a fourth alternative arrangement by which the 18 sluice gates at + 90 might be dispensed with and the whole length from C.S. 145 to C.S. 171 (1,300 feet) to be raised to + 110, automatic gates being used for about one-fourth of this length and ordinary lift shutters for the remainder. This would considerably reduce the cost of the waste weir sluices, the rate per square foot of automatic gates and lift gates being lower than that for deep level sluice gates, while the clearance necessary both in front and rear would also be appreciably lessened.

A road bridge might be arranged for, if necessary, by building piers for every 3 vents of ten feet.

Mr. Karpur Shrinivasarao pointed out that this proposal would facilitate the further raising of the full supply level of the reservoir up to + 122 feet, as suggested in the Arbitration Proceedings, should it be decided on later. The Committee agreed that this proposal would be the most convenient and economical arrangement as illustrated in Appendix II.

APPENDIX I.

Krishnarajasagara Reservoir.

Table of flood absorption between water level + 117 and + 120.

Data.

Full supply level + 118.
Maximum water level + 120.
25 sluices 8′ × 15′ at 80.
18 sluices 8′ × 14′ at 90.
35 vents with automatic shutters 10′ × 8′ at + 110.
Intensity of maximum flood 250,000 cusecs.

From level. (1)	To level. (2)	Reservoir capacity in m.c.ft. (3)	Equivalent in cusecs in one hour. (4)	Average discharge through the weir sluices. (5)	Difference between 250,000 cusecs and column 5 which will be absorbed. (6)	Time required for rise of one foot in reservoir. (7)	Total time from + 117. (8)	Remarks. (9)
+ 117	+ 118	1,193·95	351,574	160,551	89,449	3·7	..	Sluices at + 80 + 90 as well as those in the dam are discharging. Automatic vents also begin to discharge at + 118.
+ 118	+ 119	1,220·26	338,866	189,946	60,054	5·6	9·3	
+ 119	+ 120	1,247·64	346,470	197,145	52,855	6·5	15·8	

APPENDIX II.

Statement showing the proposed arrangements, etc., in case the capacity of the tank is to be raised from F.S.L. + 118 to + 122.

Details of sluices.	F.S.L. + 118. Effective head.	F.S.L. + 118. Discharge at + 118.	Details of sluices.	F.S.L. + 122. Effective head.	F.S.L. + 122. Discharge at + 122.
1. Sluices in the dam	..	30,000	Sluices in dam ..	..	Not to be opened at this level
2. Sluices in weir at + 80 25×8′× × 15′.	30½	83,100	Sluices in weir at + 80 25×8′×20′.	32′	113,200
3. Lift shutters sluices at +110 90× 10′×8′.	8′	63,180	Lift shutter sluices in weir at + 110 90×10′×12′.	12′	115,830
4. Automatic gates at + 110 30×10′ ×8′.	8′	21,060	Automatic gates at + 114 30×10′×8′.	8′	21,060
Total ..	..	197,340			250,090

With water at + 122 and top of dam at + 124 as now designed, there will be practically no margin for flood absorption and so full maximum flood is provided for in the waste weir sluices, while the lower sluices are not proposed to be opened at all at this high level. The extra cost would be only about Rs. 75,000 giving an additional storage of nearly 5,000 millions cubic feet.

PROCEEDINGS OF THE KRISHNARAJASAGARA WASTE WEIR COMMITTEE.

Tuesday, Camp Mysore, dated 25th February 1919.

On the morning of the 25th instant, the President and the Members of the Committee visited the Krishnarajasagara Waste Weir site. Inspection was made of the nature of rock met with in the foundation trenches and in the trial pits immediately behind, in the two valleys. The prevailing variety of rock, though rather soft even at depths 20 to 30 feet below ground, was considered hard enough to withstand the floods for a number of years and it was considered that no protection works were needed at present. The floods might be allowed to pass for some years to observe their effect on the bed of the surplus channel.

It was considered advisable to completely fill the foundation trench of the weir from C.S. 136 to C.S. 171 with solid masonry.

The lie of the ground at the weir site was considered suitable for the disposition of sluices and gates as proposed in alternative 4 (*vide* Proceedings of the 24th instant) although this would require the floods of 1920, being passed over the dam in the river gap at + 80 and on the bye-wash 500 feet long at the position of the + 80 sluices. Mr. Karpur Shrinivasarao's suggestion to put the automatic gates on the dividing ridge between the A and B valleys was also agreed to. In order to prevent the discharges from taking a cross direction towards valley A, a training wall was proposed to be built taking off from the south end of the + 80 level sluices at right angles to the dam for about 150 feet and then along the ridge following the contours for some further distance.

Mr. Krishnaiengar's proposal to have two toe walls, one across each of the valleys A and B as shown on the block plan, was considered unnecessary at present, the work being postponed till after the effects of floods on the waste weir channel have been observed. Any scour or cut along the valley line will greatly facilitate the construction of these walls by obviating the necessity for costly baling and shoring for the foundation work.

PROCEEDINGS OF THE KRISHNARAJASAGARA WASTE WEIR COMMITTEE.

Wednesday, Camp Mysore, 26th February 1919.

5th Term of Reference. What should be the exact nature of the protective works needed to prevent retrogression of levels in the waste weir channel and the eventual damage to the weir dam?—It is impossible for the Committee to predict to what extent protective works below the waste weir will be necessary and what form they should take. No reliable estimates can be prepared at this stage. It is probable that erosion will occur to correct which a series of cross walls may be necessary.

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6th Term of Reference.—Any other points which may arise, or be raised, incidentally.—A suggestion was made to carry the right bank channel by means of a duct along the rear of the masonry wall of the weir instead of by a long open cut as proposed which was likely to silt up by the cross currents. : (*Vide* sketch attached).

(Sd.) M. NETHERSOLE.
(,,) W. J. J. HOWLEY.
(,,) C. T. DALAL.
(,,) KARPUR SHRINIVASRAO.
(,,) K. KRISHNAIENGAR.

MYSORE EXHIBIT N-1.

OFFICE OF THE PUBLICITY OFFICER TO GOVERNMENT.

Dated Bangalore, 30*th March* 1925.

PRESS COMMUNIQUE.

Having in view the unprecedented floods that occurred in the Cauvery in July last, the Special Officer and Secretary to Government, Krishnarajasagara Works, submitted in December last, proposals relating to—

(1) the revision of the maximum flood discharge of the river at Krishnarajasagara, and

(2) the stage at which the works may be stopped for the present after June of 1925, by which time diversion of the floods to the permanent waste weir is expected to be completed.

The revised estimates for the dam are also before Government for orders.

Government appointed a Special Committee to consider and submit recommendations to them on the proposals made by the Special Officer as well as on the revised estimates pending before Government. The Committee have now submitted their report to Government, which is published herewith for general information.

R. RANGA RAO,
Publicity Officer to Government.

REPORT OF THE COMMITTEE OF ENGINEERS CONSTITUTED FOR THE CONSIDERATION OF CERTAIN MATTERS RELATING TO THE KRISHNARAJASAGARA DAM WORKS, DATED 14TH MARCH 1925.

As definite decisions had to be arrived at on several important points relating to the Krishnarajasagara Dam Works, Government proposed to appoint in January last a Committee of technical experts for considering these matters and for advising Government on the same. Sir Frederick St. John Gebbie, Consulting Engineer to the Government of India, was requested to be Member and Chairman of this Committee, Messrs. Karpur Shrinivasa Rao and B. Subba Rao being the other two members.

The Government of India who were addressed through the Residency having agreed to depute Sir Frederick St. John Gebbie for the purpose and other members having consented to serve on the Committee, the Committee met on the 13th and 14th March 1925.

The terms of reference to the Committee are:—

A. In view of the unprecedented floods of July last, for what maximum discharge should the surplusing arrangements of the Krishnarajasagara works be designed?

B. In what stage should the reservoir works be stopped till need arises for larger storage for irrigation so that unproductive capital expenditure might be postponed till the canal works are taken up and have made sufficient progress?

C. What maximum storage may ultimately be allowed in the reservoir consistent with the safety of the dam as designed?

D. Whether the revised estimates submitted for the reservoir works by the Technical officers are in order and may be sanctioned?

PRELIMINARY.

Full and detailed notes explaining all the points relating to the above terms of reference together with the necessary plans, sections, calculations, estimates, etc., were forwarded for information and previous study to each of the members of the Committee. The points relating to the terms of reference detailed in the above notes were fully discussed and the conclusions arrived at are briefly noted below with the necessary explanatory remarks :—

(A)

In view of the unprecedented floods of July last, for what maximum discharge should the surplusing arrangements of the Krishnarajasagara Works be designed?

We have examined the calculations furnished to us relating to the unprecedented flood discharge of July 1924 and we think that the provision for a discharge of 350,000 cusecs proposed by the Special Officer is quite suitable and ample, this being about 20 per cent in excess of the discharge of last year which is the highest during the past 100 years.

We have gone carefully into the question of the capacity of the surplusing works as set forth in the enclosed tabular statement * and find that the surplusing works provided, viz., the open weir of 1,200 feet with its crest at 106 above bed and 16 sluices, each 10' × 20', 80' above bed together are capable of discharging ultimately 344,527 cusecs with the maximum water level at 124 feet, excluding 10,500 cusecs through the three scouring sluices at 50 level which may also be opened as an emergent measure when floods exceed the limit noted above.

We think therefore that the surplusing works have ample capacity and that this capacity should be utilized by raising the masonry of the dam sufficiently high. The Special Officer points out that an additional weir length of about 800 feet can be arranged on the North Bank at a cost of about Rs. 4 to 5 lakhs. We agree with him in thinking that there is room for future enlargement of the weir works, but do not think it necessary to provide for it in the estimates.

(B)

In what stage should the reservoir works be stopped till need arises for a larger storage for irrigation so that unproductive capital expenditure might be postponed till the canal works are taken up and have made sufficient progress?

Our recommendations in regard to the surplusing works go towards deciding this question. We think that it is necessary to raise the masonry to 128 feet above bed level so as to have at least a margin of 4 feet above maximum flood level, thus leaving only 2 feet below the final top level of the dam, viz., 130 feet, the cost for this top portion being about rupees 2 lakhs. It may appear that this expenditure could be postponed for the present, but we think it undesirable to do so. The tram lines, mortar mills and other machinery are all now in position and we have no doubt that it will cost a great deal more than the interest charges on Rs. 2 lakhs to carry out later on this top masonry if postponed. We, therefore, recommend the completion of the work proposed in the estimate amounting to Rs. 217·18 lakhs bringing the top of the dam to 130 above bed once for all.

(C)

What maximum storage may ultimately be allowed in the reservoir consistent with the safety of the dam as designed?

We have examined the profile of the dam for storing water up to 124 feet above bed. Our attention was drawn by the Special Officer to certain Press criticisms

* Not printed

and the letters of Mr. O. T. Dalal stating that a higher storage than 118 should not be allowed. We have also considered the effect of the scours in portions of the rear face of the dam due to the overflow of water in the central gap. Sir Frederick St. John Gebbie, Chairman of this Committee, while inspecting these scours in September 1923 found by actual measurement that in only one case the depth of the scour was $3\frac{1}{2}$ feet and in other places the depth varied from $1\frac{1}{2}$ feet to 3 feet. But the dam as actually constructed has an extra thickness of 2 to 3 feet in the river bed over and above what the designed profile provides, and we have no hesitation in stating that the effect of these scours which all lie in the zone of extra thickness have in no way weakened the dam.

We find that the profile adopted satisfies fully the conditions of stability and stress required for a storage of 124 feet and these compare very favourably with the corresponding provisions made for high dams in the Bombay Presidency, viz., Bhatgar Dam and Bhandardara Dam, which are two of the highest in India. Also, the mortar used in the Krishnarajasagara Dam as indicated by the results of continuous tests, is of superior quality and the masonry is very sound.

We have considered Mr. Dalal's letters against a storage of 124 feet. He does not base his arguments on stress and stability calculations. If he had translated his objections into figures showing stability and stress and had compared them with the same figures for storage and similar figures for other Indian Dams, he would have found no room for any anxiety in the matter.

(D)

Whether the revised estimates submitted for the reservoir works by the Technical officers are in order and may be sanctioned ?

We have gone through the revised estimates placed before us. We recommend that the first set of revised estimates amounting to Rs. 217·18 lakhs net under direct charges providing for raising masonry to 130 while leaving the weir at 106 may be sanctioned.

We have also examined the second set of estimates for the ultimate stage of the reservoir works amounting to Rs. 251·32 lakhs under direct charges and the provision seems reasonable with the exception of Rs. 4 lakhs for a weir on the North Bank which may be omitted.

The following works estimated to cost about Rs. 30 lakhs and included in the second set of estimates may be postponed :—

(1) Provision of automatic gates to raise storage to 124 feet.

(2) Payment of compensation for land above 106.

(3) Constructing the parapet wall on the top with approach works.

As the extra works of this estimate not included in the estimate one noted above would naturally be postponed for several years till the high level canal and tunnel works have made fair progress, estimates for such extra works will have to be revised according to the conditions obtaining at such future date.

Summarizing, our recommendations are :—

(1) That the provision for a maximum flood discharge of 350,000 cusecs is suitable and sufficient.

(2) That the dam masonry be raised to 130 feet as proposed by the Special Officer and only works relating to automatic shutters, parapet wall and compensation for land above 106 may be postponed.

(3) That the profile of the dam, notwithstanding the rear scours which have been effectively repaired has ample strength to store water up to 124 feet above bed.

(4) That the revised estimates amounting to Rs. 217·18 lakhs providing for all works necessary to complete masonry up to 130 level is in order and may be sanctioned.

F. St. J. Gebbie,
Chairman.

Member—Karpur Shrinivasa Rao,
14-3-25.

Member—B. Subba Rao,
14-3-25.

MYSORE EXHIBITS.

(O)

Arbitration Proceedings, 1914, Volume III—Pages 541-544 (Printed separately).

(P)

Section of the Cauvery Dam (Not printed).

(Q) (Q-1) (Q-2.)

Current Meter Sections, (3) (Not printed).

(R)

Mettur Project—Volume V—Page 33 (Printed separately).

(S)

Map of Srirangam Island (Not printed).

(T)

Chart showing discharges from 1917 to 1926 (Not printed).

MYSORE EXHIBIT (U).

Note on Krishnarajasagara working Table.

Agreement has not been reached between Mysore and Madras in regard to—

(1) transmission losses in the river,

(2) rates of evaporation in the reservoir, and

(3) corrections of discharges for vertical velocities.

For facility of calculations, nil transmission losses and old rates of evaporation have been assumed and vertical velocity corrections have been applied to the discharges of 1922 according to Madras proposals. The figures for the discharges have been based on joint results and many calculations in these corrections require verification and checking as, for example, joint calculations have not been made of the Akhanda Cauvery discharges. The tables are therefore approximate. Though figures may slightly vary, conclusions from the results will not materially alter especially in regard to impounded quantities.

The revised factors for "P" on which the tables are based are ·625 south-west moonsoon, ·312 for October and ·404 for November for the tables based on limit discharges on ten continuous years. In the case of tables based on pre-breach gaugings, "P" is changed to ·404 only for November as the examination under Rule 11 in this case is confined to seven years.

The tables are prepared and furnished without prejudice to mutual settlement that may be arrived at after examination for "P" and of all other points on which no settlement has been reached. The Mysore case is that "P" should be examined up to the pre-breach period only, as the discharges after the delete-breach are not accepted.

The time of transmission is taken as four days as per rule 10, paragraph 2 of annexure I to the agreement subject to revision.

Abstract of Krishnarajasagara Reservoir Working Tables with the limit discharges based on the average of seven years and odd (pre-breach) with vertical velocity corrections and "P" based on seven and odd years' examination.

1917-18.

Month. (1)	Quantity of inflow into the Krishnarajasagara. (2)	Quantity of inflow due to Madras or quantity passed down including surplus when reservoir is full [column (2)—column (4)]. (3)	Quantity actually impounded in the Krishnarajasagara including direct draw off. (4)	Balance brought forward from column (7) of previous month. (5)	Quantity required for irrigation, power, and evaporation. (6)	Balance carried forward [column (5)—column (6)]. (7)	Result of such working on irrigation, etc. (8)
....	..	..	..	..	..	31,232	The examination of the reservoir is commenced from 1916-17 with a starting balance of 5,000 m.c.ft. for the storage capacity as per agreement.
June	10,625	9,597	1,028	32,260	3,377	28,883	
July	24,633	24,633	..	28,883	5,167	23,716	
August	32,644	31,639	1,005	24,721	5,136	19,585	
September ..	43,641	29,727	13,914	33,499	5,010	28,489	
October	47,004	25,561	21,443	49,932	5,277	44,6 5	
November ..	15,376	12,713	2,663	47,318	5,152	42,166	Supplies given as per normal irrigation requirements assumed.
December ..	5,951	3,863	2,088	44,254	4,383	39,871	
January ..	2,966	2,966	..	39,871	3,140	36,731	
Total ..	182,840	140,699	42,141	..	36,642	..	
February ..	1,539	..	1,539	38,270	2,846	35,424	
March	878	..	878	36,302	4,335	31,967	
April	662	..	662	32,629	4,457	28,172	
May	2,816	..	2,816	30,988	2,870	28,118	The total quantity impounded is slightly less than the normal requirements and but for the high starting balance there would have been partial failure.
Total ..	188,735	140,699	48,036	..	51,150	..	

1918-19.

Month. (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
....	..	..	..	..	..	28,118	
June	16,721	15,647	1,074	29,192	3,172	26,020	
July	15,803	15,803	..	26,020	5,172	20,848	
August	29,708	23,000	6,708	27,556	5,143	22,413	
September ..	10,804	10,804	..	22,413	4,985	17,428	The quantity impounded during the year is less than half the normal requirements of irrigation and power.
October	5,723	5,723	..	17,428	5,104	12,324	
November ..	13,273	8,093	5,180	17,504	4,930	12,574	
December ..	10,828	2,812	8,016	20,590	4,217	16,373	
January	2,287	2,287	..	16,373	2,969	13,404	
Total ..	105,147	84,169	20,978	..	35,692	..	
February ..	1,155	..	1,155	14,559	2,545	12,014	
March	655	..	655	12,669	3,749	8,920	
April	232	..	232	9,152	3,964	5,188	
May	997	..	997	6,185	2,400	3,785	The balance available for working the reservoir is inadequate and there is deficiency in May for normal requirements.
Total ..	108,186	84,169	24,017	..	48,350	..	

Month.	Quantity of inflow into the Krishnarajasagara.	Quantity of inflow due to Madras or quantity passed down including surplus when reservoir is full [column (2)—column (4).]	Quantity actually impounded in the Krishna rajasagara including direct draw off.	Balance brought forward from column (7) of previous month.	Quantity required for irrigation, power and evaporation.	Balance carried forward [column (5)—column (6).]	Result of such working on irrigation, etc.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1919-20.							
June	.. 16,954	.. 12,039	.. 4,915	.. 8,700	.. 2,893	3,785 5,807	The year begins with a very low balance and perennial crops suffer. Issue to fresh irrigation is delayed.
July	33,497	31,831	1,666	7,473	5,001	2,472	
August	58,421	33,900	24,521	26,993	5,135	21,858	
September ..	25,818	24,668	1,150	23,008	4,972	18,036	
October	15,490	13,682	1,808	19,844	5,130	14,714	
November ..	21,281	12,233	9,048	23,762	4,985	18,777	
December ..	5,848	4,491	1,357	20,134	4,251	15,883	
January	3,355	2,954	401	16,284	3,000	13,284	
Total ..	180,664	135,798	44,866	..	35,367	..	
February ..	1,644	..	1,644	14,928	2,224	12,704	
March	757	..	757	13,461	3,593	9,868	
April	550	..	550	10,418	3,503	6,915	
May	564	..	564	7,479	4,003	3,476	The balance available in the month of May is also inadequate for normal working. Thus on the whole it is a bad year both at the commencement and end.
Total ..	184,179	135,798	48,381	..	48,690	..	
1920-21.							
June	.. 18,567	.. 12,426	.. 6,141	.. 9,617	.. 3,002	3,476 6,615	Perennial crop suffers till the 25th June and monsoon irrigation has to be delayed ten days.
July	1,15,[illegible]92	71,886	43,406	50,521	5,194	44,827	
August	50,276	49,141	1,135	45,962	5,301	40,661	
September ..	16,621	16,621	..	40,661	5,121	35,540	
October	9,488	9,488	..	35,540	5,242	30,298	
November ..	10,942	7,591	3,351	33,649	5,069	28,580	
December ..	5,371	5,185	186	28,766	4,275	24,491	
January	1,675	1,675	..	24,491	3,025	21,466	
Total ..	228,232	174,013	54,219	..	36,229	..	
February ..	890	..	890	22,356	3,101	19,255	
March	691	..	691	19,946	3,978	15,968	
April	1,099	..	1,099	17,067	2,853	14,214	
May	1,199	..	1,199	15,413	3,363	12,050	
Total ..	232,111	174,013	58,098	..	49,524	..	
1921-22.							
June	15,666	6,731	8,935	[illegible]0,985	3,032	12,050 17,953	
July	34,693	8,383	26,310	44,263	5,122	39,141	
August	127,029	116,726	10,305	49,444	5,301	44,143	
September ..	40,233	37,430	2,803	46,946	5,159	41,787	The working of the reservoir is normal.
October	15,050	12,244	2,806	44,593	5,301	39,292	
November ..	7,685	7,685	..	39,29[illegible]	5,115	[illegible]4,177	
December ..	2,676	2,676	..	34,177	4,328	29,849	
January	2,304	2,190	114	29,963	3,060	26,903	
Total ..	245,336	194,065	51,271	..	36,418	..	
February ..	954	..	954	27,857	1,906	25,951	
March	516	..	516	26,467	3,723	22,744	
April	127	..	127	22,871	4,036	18,835	
May	2,042	..	2,042	20,877	2,822	18,055	
Total ..	248,975	194,065	54,910	..	48,905	..	

Month. (1)	Quantity of inflow into the Krishnarajasagara. (2)	Quantity of inflow due to Madras or quantity passed down including surplus when reservoir is full [column (2)—column (4)]. (3)	Quantity actually impounded in the Krishnarajasagara including direct draw off. (4)	Balance brought forward from column (7) of previous month. (5)	Quantity required for irrigation, power and evaporation. (6)	Balance carried forward [column (5)—column (6)]. (7)	Result of such working on irrigation, etc. (8)
1922-23.							
June	1,183	1,183	..	18,055	3,056	18,055 14,999	As in the year 1919-20, the impounded quantity is in this year also less than what is necessary to meet the normal requirements of irrigation and power.
July	69,480	37,917	31,563	46,562	5,133	41,429	
August	55,585	49,677	5,908	47,337	5,301	42,056	
September ..	26,968	26,919	49	42,085	5,150	36,955	
October	12,598	12,365	233	37,188	5,270	31,918	The reservoir working is normal due to the large balance at the beginning of the year.
November ..	15,070	10,801	4,269	36,187	5,115	31,072	
December ..	4,382	3,842	540	31,612	4,349	27,263	
January	1,911	1,911	..	27,263	3,088	24,175	
Total ..	187,177	144,615	42,562	..	36,442	..	
February ..	1,039	..	1,039	25,214	3,145	22,069	
March	627	..	627	22,696	3,580	19,116	
April	867	..	867	19,983	3,476	16,507	
May	419	..	419	16,926	4,295	12,631	
Total ..	190,129	144,615	45,514	..	50,938	..	
1923-24.							
June	3,202	3,202	..	12,631	3,018	12,631 9,613	
July	123,442	83,035	40,407	50,020	5,193	44,827	
August	198,737	193,436	5,301	50,128	5,301	44,827	
September ..	34,810	32,641	2,169	46,996	5,130	41,866	
October	13,079	12,913	166	42,032	5,301	36,731	The working of the reservoir is normal.
November ..	5,330	5,330	..	36,731	5,115	31,616	
December ..	2,717	2,717	..	31,616	4,321	27,295	
January	749	749	..	27,295	3,046	24,249	
Total ..	382,066	334,023	48,043	..	36,425	..	
February to May.	3,822	..	3,822	28,071	14,328	13,743	During the summer months February to May the figures for natural flows at the Krishnarajasagara are not available. The average of the inflows of previous years from 1917 to 1923 have been calculated and assumed to be the inflow during the above months in this and subsequent years. The figures taken for power and evaporation are average and approximate.
Total ..	385,888	334,023	51,865	..	50,753	..	

Month. (1)	Quantity of inflow into the Krishnarajasagara. (2)	Quantity of inflow due to Madras or quantity passed down including surplus when reservoir is full [column (2)—column (4)] (3)	Quantity actually impounded in the Krishnarajasagara including direct draw off. (4)	Balance brought forward from column (7) of previous month. (5)	Quantity required for irrigation, power and evaporation. (6)	Balance carried forward [column (5)—column (6)]. (7)	Result of such working on irrigation, etc. (8)

1924-25.

Month. (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
						13,743	
June	12,684	12,684	..	13,743	2,993	10,750	
July	208,185	168,921	39,264	50,014	5,187	44,827	
August	78,288	75,381	2,907	47,734	5,301	42,433	
September ..	32,368	30,707	1,661	44,094	5,130	38,964	
October	16,530	11,611	4,919	43,883	5,301	38,582	
November ..	7,016	7,016	..	38,582	5,115	33,467	The working of the reservoir is normal.
December ..	5,204	3,291	1,913	35,380	4,321	31,059	
January	Figure not available.	..	..	31,059	3,062	27,997	
Total ..	360,275	309,611	50,664	..	36,410	..	
February ..	1,204	..	3,822	31,819	14,380	17,439	Vide remarks for 1923-24.
March	687	..					
April	591	..					
May	1,340	..					
Total ..	364,097	309,611	54,486	..	50,790	..	

1925-26

Month. (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
						17,439	
June	7,851	3,624	4,227	21,666	3,063	18,603	
July	109,221	78,630	30,591	49,194	5,222	43,972	
August	34,049	33,634	415	44,387	5,301	39,086	
September ..	27,069	20,644	6,425	45,511	5,130	40,381	
October	13,956	8,821	5,135	45,516	5,301	40,215	
November ..	8,892	5,503	3,389	43,604	5,115	38,489	The reservoir working is normal.
December ..	6,784	3,479	3,305	41,794	4,321	37,473	
January	Not available.	1,253	..	37,473	3,093	34,380	
Total ..	207,822	155,588	53,487	..	36,546	..	
February ..	1,204	..	3,822	38,202	14,620	23,582	Vide remarks for 1923-24.
March	687	..					
April	591	..					
May	1,340	..					
Total ..	211,644	155,588	57,309	..	51,166	..	

1926-27.

Month. (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
						23,582	
June	1,301	1,301	..	23,582	3,053	20,529	
July	60,475	30,926	29,549	50,078	5,251	44,827	
August	138,309	133,863	4,446	49,273	5,301	43,972	
September ..	37,186	34,733	2,453	46,425	5,130	41,295	
October	21,106	13,470	7,636	48,931	5,301	43,630	
November ..	6,596	6,596	..	43,630	5,130	38,500	The working of the reservoir is normal.
December ..	2,647	2,647	..	38,500	4,352	34,148	
January	1,556	1,556	..	34,148	3,093	31,055	
Total ..	269,176	225,092	44,084	..	36,611	..	
February to May.	3,822	..	3,822	34,877	14,500	20,377	Vide remarks for 1923-24.
Total ..	272,998	225,092	47,906	..	51,111	..	

MYSORE EXHIBIT U-1.

Abstract of Krishnarajasagara Working Tables with limit discharges based on 10 years' average with vertical velocity corrections and "P" based on ten years' examination.

Month. (1)	Quantity of inflow into the Krishnarajasagara. (2)	Quantity of inflow due to Madras or quantity passed down including surplus when reservoir is full (3)	Quantity actually impounded in the Krishnarajasagara including direct draw-off. (4)	Balance brought forward from column (7) of previous month. (5)	Quantity required for irrigation, power evaporation. (6)	Balance carried forward column (5)—column (6). (7)	Result of such working on irrigation, etc. (8)
1917-18							
						30,986	The balance is based on the working of the previous year starting with a balance of 5000 m.c.ft. as in the case of "A" form table to bring capacity into action.
June	10,625	9,912	713	31,699	3,377	28,322	
July	24,633	24,633	..	28,322	5,177	23,145	
August	32,644	32,367	277	23,422	5,146	18,276	
September ..	43,641	32,072	11,569	29,845	4,980	24,865	
October	47,004	22,131	24,873	49,738	5,255	44,483	Reservoir working is normal due to the large balance brought forward from the previous year.
November ..	15,376	13,404	1,972	46,455	5,146	41,310	
December ..	5,951	4,596	1,355	42,665	4,368	38,297	
January	2,966	2,966	..	38,297	3,124	35,173	
	182,840	142,081	40,759	..	36,572	..	
February ..	1,539	..	1,539	36,712	2,828	33,884	
March	878	..	878	34,762	4,295	30,467	
April	662	..	662	31,129	4,394	26,735	
May	2,816	..	2,816	29,551	2,840	26,711	
	188,735	142,081	46,654	..	50,929	..	
1918-19							
						26,711	
June	16,721	16,320	441	27,152	3,128	24,024	
July	15,803	15,803	..	24,024	5,146	18,878	
August	29,708	25,017	4,691	23,569	5,131	18,438	
September ..	10,804	10,804	..	18,438	4,950	13,488	
October	5,723	5,723	..	13,488	5,069	8,419	
November ..	13,278	9,564	3,709	12,128	4,875	7,253	
December ..	10,828	3,258	7,570	14,823	4,123	10,700	
January	2,287	2,287	..	10,700	2,901	7,799	
	105,147	88,776	16,411	..	35,323	..	Storage very poor.
February ..	1,155	..	1,155	8,954	2,472	6,482	Reservoir fails from March to May 1919 and perennial crop suffers. Minus figures indicate actual deficiency exclusive of the minimum starting balance of 5,000 m.c.ft. for working the reservoir. It will be noticed that by increasing the limit discharges corresponding to pre-breach period to those of continuous ten years the loss of impounding caused in this bad year is about 5,000 m.c ft.
March	655	..	655	7,137	3,645	3,492	
April	232	..	232	3,724	3,826	— 102 Nil.	
May	997	..	997	895	2,264	— 1,369	
	108,186	88,776	19,450	..	47,530	..	

Month. (1)	Quantity of inflow into the Krishnarajasagara. (2)	Quantity of inflow due to Madras or quantity passed down including surplus when reservoir is full. (3)	Quantity actually impounded in the Krishnarajasagara including direct draw-off. (4)	Balance brought forward from column (7) of previous month. (5)	Quantity required for irrigation, power and evaporation. (6)	Balance carried forward [column (5) – column (6).] (7)	Result of such working on irrigation, etc. (8)
1919-20.							
June	16,954	13,526	3,428	3,428	2,843	Nil. — 585	
July	33,497	32,615	882	1,467	4,935	(— 3,468 Nil.)	Reservoir fails in June and July 1919 and from October 1919 to end of May 1920 or in other words it fails completely.
August	58,421	36,687	21,734	18,266	5,038	13,228	
September ..	25,818	25,195	623	13,851	4,905	8,946	
October	15,490	14,144	1,346	10,292	5,022	5,270	
November ..	21,281	14,192	7,089	12,359	4,860	7,499	
December ..	5,848	5,557	291	7,790	4,089	3,701	
January ..	3,355	3,279	76	3,777	2,830	947	
	180,664	145,195	35,469	..	34,522	..	
February ..	1,644	..	1,644	2,591	2,021	570	
March	757	..	757	1,327	3,356	— 2,029 Nil.	
April	550	..	550	— 1,479	3,187	— 4,666 Nil.	The total deficiency during the year is about 8,000 plus 5,000 m.c. ft
May	564	..	564	— 4,102	3,681	— 7,783	
	184,179	145,195	38,984	..	46,767	..	
1920-21.							
June	18,567	13,972	4,595	4,595	2,843	Nil. 1,752	Reservoir fails in June and up to 10th July as the balance was nil.
July	115,292	67,023	48,269	50,021	5,194	44,827	
August	50,276	49,421	855	45,682	5,301	40,331	
September ..	16,621	16,621	..	40,381	5,121	35,260	
October	9,488	9,488	..	35,260	5,242	30,018	
November ..	10,942	8,362	2,580	32,598	5,040	27,558	
December ..	5,371	5,353	18	27,576	4,259	23,317	
January	1,675	1,675	..	23,317	3,000	20,317	
	228,232	171,915	58,317	..	36,000	..	
February ..	890	..	890	21,207	3,101	18,106	
March	691	..	691	18,797	3,950	14,847	
April	1,099	..	1,099	15,946	2,815	13,131	
May	1,199	..	1,199	14,330	3,301	11,029	
	232,111	171,915	60,196	..	49,167	..	
1921-22.							
						11,029	
June	15,666	7,953	7,713	18,742	3,032	15,710	
July	34,693	8,745	25,948	41,658	5,095	36,563	
August	127,029	114,148	12,881	49,444	5,301	44,143	
September ..	40,233	37,486	2,747	46,890	5,159	41,731	
October ..	15,050	13,838	1,212	42,943	5,301	37,642	The working of the reservoir is normal.
November ..	7,685	7,685	..	37,642	5,100	32,542	
December ..	2,676	2,676	..	32,542	4,290	28,252	
January ..	2,304	2,304	..	28,252	3,031	25,221	
	245,336	194,835	50,501	..	36,309	..	
February ..	954	..	954	26,175	1,906	24,269	
March	516	..	516	24,785	3,723	21,062	
April	127	..	127	21,189	4,021	17,168	
May	2,042	..	2,042	19,210	2,822	16,388	
	248,975	194,835	54,140	..	48,781	..	

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Month	Quantity of inflow into Krishnarajasagara.	Quantity of inflow due to Madras or quantity passed down including surplus when reservoir is full [column (2)—column (4)].	Quantity actually impounded in Krishnarajasagara including direct draw off.	Balance brought forward from column (7) of previous month.	Quantity required for irrigation, power and evaporation.	Balance carried forward [column (5)—column (6).]	Result of such working on irrigation, etc.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1922-23.							
						16,388	
June	1,183	1,183	..	16,388	3,053	13,335	
July	69,480	40,782	28,698	42,033	5,133	36,900	
August	55,585	53,202	2,383	39,283	5,270	34,013	
September ..	26,968	26,968	..	34,013	5,070	28,943	
October ..	12,598	12,598	..	28,943	5,177	23,766	
November ..	15,070	12,774	2,296	26,062	5,010	21,052	Partial failure in May 1923.
December ..	4,382	4,134	248	21,300	4,213	17,087	
January ..	1,911	1,911	..	17,087	2,969	14,118	
	187,177	153,552	33,625	..	35,895	..	
February ..	1,039	..	1,039	15,157	3,016	12,141	
March	627	..	627	12,768	3,409	9,359	
April	867	..	867	10,226	3,200	7,026	
May	419	..	419	7,445	3,970	3,475	
	190,129	153,552	36,577	..	49,490	..	
1923-24.							
						3,475	Supply insufficient for irrigation.
June	3,202	3,202	..	3,475	2,873	602	
July	123,442	74,120	49,322	49,924	5,097	44,827	
August	198,737	193,436	5,301	50,128	5,301	44,827	
September ..	34,810	33,290	1,520	46,347	5,130	41,217	
October	13,079	13,079	..	41,217	5,301	35,916	
November ..	5,330	5,330	..	35,916	5,115	30,801	
December ..	2,717	2,717	..	30,801	4,321	26,480	
January	749	749	..	26,480	3,046	23,434	
	382,066	325,923	56,143	..	36,184	..	
February to May.	* 3,822	..	3,822	27,256	14,231	13,025	* During the summer months February to May the figures for natural flows at the Krishnarajasagara are not available. The average of the inflows of previous years from 1917 to 1923 have been calculated and assumed to be the inflow during the above months in this and subsequent years.
	385,888	325,923	59,965	..	50,415	..	
1924-25.							
						13,025	
June	12,684	12,684	..	13,025	2,993	10,032	
July	208,185	168,203	39,982	50,014	5,187	44,827	
August	78,288	75,381	2,907	47,734	5,301	42,433	
September ..	32,368	31,630	738	43,171	5,130	38,041	
October	16,530	13,783	2,747	40,788	5,301	35,487	
November ..	7,016	7,016	..	35,487	5,115	30,372	
December ..	5,204	3,942	1,262	31,634	4,244	27,390	
January	Not available.	..	..	27,390	3,031	24,359	
	360,275	312,639	47,636	..	36,502	..	
February to May.	3,822	..	3,822	28,181	14,230	13,951	Vide remarks for 1923-24.
	364,097	312,639	51,458	..	50,532	..	

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Month.	Quantity of inflow into Krishnarajasagara.	Quantity of inflow due to Madras or quantity passed down including surplus when reservoir is full [column (2)—column (4).]	Quantity actually impounded in Krishnarajasagara including direct draw off.	Balance brought forward from column (7) of previous month.	Quantity required for irrigation power and evaporation.	Balance carried forward [column (5)—column (6).]	Result of such working on irrigation, etc.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1925-26.							
						13,951	
June	7,851	4,124	3,727	17,678	3,038	14,640	
July	109,221	74,667	34,554	49,194	5,222	43,972	
August	34,049	33,815	234	44,206	5,301	38,905	
September ..	27,069	21,136	5,933	44,838	5,130	39,708	
October	13,956	10,564	3,392	43,100	5,301	37,799	
November ..	8,892	5,727	3,165	40,964	5,115	35,849	
December ..	6,784	3,699	3,085	38,934	4,821	34,613	
January	Not available.	..	..	34,613	3,093	31,520	
	207,822	153,732	54,090	..	36,521	..	
February to May.	3,822	..	3,822	35,342	14,500	20,842	Vide remarks for 1923-24.
	211,644	153,732	57,912	..	51,021	..	
1926-27.							
						20,842	
June	1,301	1,301	..	20,842	3,083	17,759	
July	60,475	28,156	32,319	50,078	5,251	44,827	
August	138,309	133,960	4,349	49,176	5,301	43,875	
September ..	37,186	35,875	1,311	45,185	5,130	40,056	
October	21,106	15,410	5,696	45,752	5,301	40,451	
November ..	6,596	6,596	..	40,451	5,130	35,321	
December ..	2,647	2,647	..	35,321	4,352	30,969	
January	1,556	1,556	..	30,969	3,093	27,876	
	269,176	225,501	43,675	..	36,641	..	
February to May.	3,822	..	3,822	31,698	14,380	17,318	Vide remarks for 1923-24.
	272,998	225,501	47,497	..	51,021	..	

MYSORE EXHIBITS

(V)

Correspondence subsequent to 1924 (page 1—Letter, dated 1st December 1924, from Madras to Mysore). (Printed separately)

(V-1)

Correspondence subsequent to 1924 (pages 4 to 6)—Letter, dated 2nd October 1924, from Madras to Mysore. (Printed separately)

(W)

Cauvery Reservoir Project—Part IV—Letter, dated the 27th February 1913, from Madras to the Hon'ble the Resident in Mysore. (Printed separately)

(X)

*Sketch showing the flow of water before, during, and after breach. (Not printed).

MYSORE EXHIBIT Y.

Note on the effect of a high flood on the movement of sand.

The joint gauging observations show that with a depth of flow of just over 10 feet, the mean velocity of flow is nearly $4\frac{1}{2}$ feet per second. This gives a bed velocity of 3 feet per second which is sufficient to roll even pebbles. With a depth

of nearly 15 feet of water flowing in the river, the mean velocity developed will be high enough to churn the sand. When big and deep breaches opened out in the banks and a fall was created, the velocity is increased considerably and an enormous quantity of sand should have been washed out. The floods of July 1924 continued for about 12 days at a very high level and the effect of these with deep breach gaps wide open in the banks, there is no wonder that the bed was scoured to the extent it did actually.

MYSORE EXHIBITS

(Z)

Notice of Mysore to admit facts. (Printed separately)

(Z-1)

Madras reply to Mysore demand for admissions. (Printed separately)

(AA)

* Discharge curve. (Not printed)

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MYSORE-MADRAS CAUVERY ARBITRATION, 1929

EXHIBITS FILED BY MADRAS.

36

LIST OF EXHIBITS FILED BY MADRAS.

I. Letter to the Right Hon'ble the Secretary of State for India (through the Government of India, Public Works Department), No. 1 I., dated 26th July 1916.

* II. Enquiry into the question of storage of the Cauvery waters within Mysore Territory; Mysore-Madras Arbitration, 1913-14, † Volume I—
(a) Page 81, Madras claim as to quantities of water for prescriptive rights.
(b) Pages 139—143, Arbitrator's award on terms of reference 2 (b).
(c) Page 86.
(d) Page 96.
(e) Page 109.
(f) Page 116.
(g) Page 89.
(h) Pages 184—187.
(j) Page 200.
(k) Page 124.

III. Note showing that the question of Mettur reservoir is not relevant for the purpose of determining the extent of impounding and that there is no difficulty in ascertaining discharges for limit gauges.
(a) Interception of water by Mettur and finding out "P".

* IV. Enquiry into the question of storage of the Cauvery waters within Mysore Territory; Mysore-Madras Arbitration, 1913-14, Volume II, page 191.†

V. Col. Love's Hydraulics, page 91, paragraph 105—Regime of rivers.

VI. (a) Gazetteer of the Tanjore district (published in 1906), Volume I, page 108.
(b) Gazetteer of the Tanjore district (published in 1906), Volume I, pages 150—153, regarding floods.
(c) Gazetteer of the Tanjore district (published in 1906), Volume I, page 13 regarding the failure of the Coleroon bridge near the Coleroon Railway Station.

VII. Gazetteer of the Trichinopoly district (published in 1907), Volume I, pages 193—195, regarding floods.

VIII. Statement showing water levels and the discharges of the floods of 1896, 1911 and 1924.

IX. Administration Report of the Madras Public Works Department for 1896-97—
(a) Page 11.
(b) Page 13.
(c) Page 35.

X. G.O. No. 1049 I., dated 12th December 1896—Letter from the Executive Engineer, Trichinopoly Division, to the Superintending Engineer, VI Circle, dated 19th October 1896, No. 459-S.E., regarding floods and breaches in 1896.

XI. Administration Report of the Madras Public Works Department (Irrigation) for 1909-10, page 17, regarding the breaching of the Grand Anicut.

XII. Administration Report of the Madras Public Works Department (Irrigation) for 1911-12, page 6, paragraph 13; page 7, paragraph 14; and page 18, paragraph 68, regarding floods of 1911.

XIII. Letter from the Executive Engineer, Trichinopoly Division, to the Superintending Engineer, VI Circle, dated 9th August 1911, No. 673-S.E., regarding the breaches in the Cauvery and Coleroon in July 1911.
* (a) Blue print showing the positions of breaches in the floods of 1911.

XIV. Letter from the Collector of Trichinopoly, to the Secretary to the Board of Revenue (Settlement), dated 22nd July 1911, No. R.C. 2613-Rev. of 1911.

XV. Madras Government G.O. No. 48 I., dated 9th February 1921, regarding the floods of 1920—Extract from—.

XVI. Letter from the Executive Engineer, Trichinopoly Division, to the Superintending Engineer, Trichinopoly Circle, dated 8th March 1924, No. 526-S.E., regarding the floods in 1923—Extract from—.

XVII. Madras Government G.O. No. 299 I., dated 22nd March 1897, containing Colonel Smart's Report regarding anticipation of floods, if water is over 11·5 feet—Extract from—.

* Not printed. † The reference is to the Mysore Print of Volumes.

XVIII. Rules for patrolling the Cauvery banks during high floods, Trichinopoly division, dated 2nd June 1916—Extract from—.

* XIX. Enquiry into the question of the storage of the Cauvery waters within Mysore Territory, † Volume IV—
(a) Page 195.
(b) Page 196.

‡ XX. Joint notes on the joint Mysore-Madras gaugings, page 3, paragraph 7.
(a) Joint notes on the joint Mysore-Madras gaugings, page 16.

XXI. Extract of paragraph 2 of the Note on the Vertical Velocity Observations of 1919 at the Upper Anicut received with letter No. 1311/KSS., dated 26th December 1923, of the Special Officer, Krishnarajasagara Works.

XXII. Cauvery Dam—Average bed levels—1924 and 1925.
(a) Note on average bed levels.
(b) Bellasis "Hydraulics with working tables" (4th Edition), page 301—Slope of stream to be observed at both banks.
(c) Bellasis "Hydraulics with working tables," pages 36—38—Movements of solid by a stream.
* (d) Bellasis "Hydraulics with working tables," page 195—Rugosity.
* (e) Bellasis "Hydraulics with working tables," page 279—Drop-down curve (curve shown to the Arbitrator).
‡ (f) Abstract statements of discharges, etc., at the Cauvery Dam gauging station at the Upper Anicut from 1917 to 1926.

XXIII. Cauvery Dam discharges, 1909, 1917 to 1926, and the averages, of 3, $7\frac{1}{4}$ and 10 years.

* XXIV. (a), (b), (c) Cross sections of the Cauvery at the Cauvery Dam for ten years (to show variations in consecutive years, plotted from summer charts).

XXV. Strange—"Irrigation, Roads and Buildings," page 61—Scouring and velocity of water.
(a) Strange—"Irrigation, Roads and Buildings," pages 333–34—Velocity and scouring and silting.

XXVI. Ellis' "Irrigation Manual," page 75—Eroding power of water.

XXVII. Russell "River Development," page 21—Transporting power of streams.

XXVIII. Statement showing the number of days on which there was a flood of $11\frac{1}{2}$ feet and over, at the Cauvery Dam North Gauge in 1896, 1911 and 1924.

XXIX. Cauvery Dam discharges—Discharges of 1909, 1917 to 1926 and the average of 3, $7\frac{1}{4}$ and 10 years, as percentages of 1919 discharges.
* (a) Diagram showing the agreed discharges of each year (1909 and 1917 to 1926) expressed as a percentage of the 1919 discharge for 3·0 feet reading on the Cauvery Dam North Gauge.
* (b) Diagram showing the agreed discharges of each year (1909 and 1917 to 1926) expressed as a percentage of the 1919 discharge for 3·5 feet reading on the Cauvery Dam North Gauge.
* (c) Diagram showing the agreed discharges of each year (1909 and 1917 to 1926) expressed as a percentage of the 1919 discharge for 7·5 feet reading on the Cauvery Dam North Gauge.

XXX. Statement showing loss in limit gauge levels under 1926 conditions entailed by the adoption of the 10 years' average, the 3 years' average and the $7\frac{1}{4}$ years' average.

XXXI. Statement showing variations of actual gauged discharges from the accepted discharges, 1923.

* XXXII. Sketch map of the Cauvery from the Amaravati infall to the Grand Anicut (showing Kodingal channel which conveyed the Murungapet breach water back to the river).

XXXIII. Note comparing levels of breachs and the Cauvery bed level at Murungapet.
* (a) Longitudinal and cross sections of the Kanavanur and Murungapet breaches along the new railway line.
* (b) Site survey showing the two breaches at Murungapet.
* (c) Land plan for Murungapet breaches, Muttarasanallur village, Trichinopoly taluk (showing also the new diversion of flood bank).
* (d) Cross section of the reclaimed wet fields and the Cauvery river in Muttarasanallur village near 34 miles 1 furlong.

* Not printed. † The reference is to the Mysore print of volumes. ‡ Printed separately.

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XXXIV. *(a) Site survey showing the lower and upper korambus at the Kilikkudu breach.

(b) Tracing from the conservancy map of the Cauvery showing the Kilikkudu breach at 16 miles 2 furlongs of left bank.

*(c) Kilikkudu breach at 16/2 of the Cauvery left bank (site survey and cross sections).

*(d) Water readings at the site of the Kilikkudu breach at 16 miles 2 furlongs of the left bank of the Cauvery, during closing of the breach.

XXXV. Administration Report of the Madras Public Works Department (Irrigation) 1923-24, page 6 and 1924-25, page 10, showing that water was taken for irrigation both above and below Kilikkudu.

*XXXVI. Dawson's "Engineering Works of the Mississippi", page 81—Ring bund for closing breach.

*XXXVII. The Cauvery Mettur Reservoir Project—Index map (showing the Urachi gauging site and topography).

XXXVIII. *(a) Area gauge diagram—Urachi gauging station, 1923.

*(b) Area gauge diagram—Urachi gauging station, 1924.

(c) Note on the changes in sectional areas at Urachi in 1923 and 1924.

(d) Statement of gauge readings and areas at Urachi from which curves are plotted.

*(e) Cross section at Urachi gauging site before and after the 1924 floods.

(f) Table of discharges of the Cauvery at Urachi, 1923, 1924 and 1925.

XXXIX. Comparison of discharges at the same stages for periods immediately before and after closing of the Murungapet breach (1924).

(a) Cauvery Dam, 1924—Discharge before and after the closing of the Murungapet breach—Curve showing —.

XL. Examination of Srirangam Nattuvoikal headsluice readings—

*(a) Relation curve of the Cauvery Dam North Gauge and Srirangam Nattuvoikal front gauge for 1924 (to show what depressions in level had taken place as a result of the Murungapet breach discharge).

(b) Relation curve of the Cauvery Dam North Gauge and Srirangam Nattuvoikal front gauge for 1925.

XLI. Probable discharges for 7·5 gauge for 1917—1923, assuming that the Cauvery Dam had no silt on it—Note regarding—

(a) Areas at gauging site for 7·5 gauge at the Cauvery Dam North Gauge.

*(b) Parker—"The Control of Water"—Pages 472—474 (Manning's formula).

*(c) Sections at the gauging section and at the Cauvery Dam to show the greater roughness at the former site.

XLII. Note on drop-down curve showing the fall in the water level at various places above the Murungapet breach.

*(a) Drop-down curve for 7·5, Cauvery Dam North Gauge, during 1924 with Murungapet breach open.

*XLIII. Merriman "Treatise on Hydraulics," page 288—Rugosity.

XLIV. Note on breaches.

XLV. "Irrigation in the Madras Provinces" by Col. R. Baird Smith, published in 1856, page 23, regarding the construction of the Cauvery Dam at bed level of the river.

XLVI. Afflux and corrected discharges for the years 1924 and 1925 with calculations and extract from "River Training and Control on the Guide Bank System" by Mr. F. J. E. Spring.

*(a) Colonel Love's Hydraulics—Drowned Anicuts, page 31.

*(b) Colonel Love's Hydraulics—Co-efficient for discharge of bridge openings, page 34.

*(c) Colonel Love's Hydraulics—Afflux, page 35.

*(d) Colonel Love's Hydraulics—Example 9, page 38.

*XLVII. Enquiry into the storage of the Cauvery waters within Mysore Territory, Volume IV, † pages 1—12—Madras appeal to the Government of India, No. 200 I., dated 21st April 1915.

XLVIII. Note on the working tables of Mysore for the Krishnarajasagara (Mysore Exhibits U and U 1.)

XLIX. Note on Proportion Factor.

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* Not printed.

† The reference is to the Mysore print of the Volume.

L. Note on how the breach in the Cauvery Dam would have occurred.
  (a) Extract from Stoney's Paper on "Extraordinary Floods in Southern India."
  (b) Minutes of the Proceedings of the Institute of Civil Engineers, Volume 218, page 160—Frederick Newhouse.
  * (c) Sketch to explain the breaching of the Cauvery Dam.
  (d) Query by the Arbitrator and the reply of Madras.

* LI. Plan of the Cauvery Dam at the Upper Anicut showing the crest level (as restored in 1926).

* LII. Site survey of $\frac{\text{Gauging operation}}{\text{Current meter section}}$ at the Upper Anicut.

* LIII. Correspondence relating to the Cauvery Arbitration Negotiations with Madras —March 1920 to August 1923, Volume I—
  (a) Mr. Howley's letters, dated 2nd and 4th May 1920, page 4.
  (b) Mr. Cadambi's letter, dated 5th May 1920, page 4.
  (c) Mr. Howley's letter, dated 5th May 1920, on limit gauges, page 5.
  (d) Mr. Howley's letter, dated 6th May 1920, safeguarding Madras interests and the relative unimportance of Mysore project, page 6.
  (e) Mr. Howley's final offer of limit gauges, page 7.
  (f) Mr. Howley's letter, dated 27th May 1920, regarding the limit gauges; essence gauges, not discharges.
  (g) Table showing limit gauges and discharges (page 9)
  (h) Mr. Cadambi's letter, dated 24th July 1920, accepting limit gauges, page 17.
  (j) Mr. Howley's letter, dated 18th September 1920, enclosing note as to limit gauges, etc., page 31.
  (k) Mr. Cadambi's letter, dated 29th September 1920, page 35.
  (l) Rules of Regulation reference to conditions of Upper Anicut shutters, page 41.
  (m) Mr. Cadambi's demi-official, dated 31st October 1920, regarding the Rules of Regulation. Rule I—Regulation of Upper Anicut Gaugings, pages 50–51.
  (n) Resident's demi-official to Mr. Banerjee, dated 18th November 1920, that Madras insists on limit gauges for all time, page 62.
  (p) Rules of Regulation. Madras accept proposal on pages 51 and 63.
  (q) Demi-official from the Mysore Chief Engineer to the Chief Engineer, Madras, dated 27th January 1921, page 69.

† LIV. Correspondence between Madras and Mysore relating to the gauging in connexion with the breaches at the Cauvery Dam after the flood of 1924—
  (a) Letter, dated 8th November 1924.
  (b) Do. 1st December 1924.
  (c) Do. 16th April 1925.
  (d) Do. 2nd June 1925.
  (e) Do. 2nd October 1925.
  (f) Do. 21st January 1926.
  (g) Do. 20th May 1926.
  (h) Do. 31st March 1927.
  (i) Do. 19th August 1927 (paragraph 10 only).

LV. Quantity represented by the difference between the 10 years' and $7\frac{1}{4}$ years' averages.

* Not printed. † Separately printed.

MADRAS EXHIBIT I

Letter to the Right Hon'ble the Secretary of State for India (through the Government of India, Public Works Department), No. 1 I., dated the 26th July 1916.

To

THE RIGHT HON'BLE THE SECRETARY OF STATE FOR INDIA

(*through the Government of India, Public Works Department*).

RIGHT HON'BLE SIR,

Letter from the Government of India No. 082 I., dated 30th March 1916 (*Annexure* 15).

We find ourselves unable to acquiesce in the orders passed by the Government of India in the matter of a dispute with the Mysore Darbar regarding the proposed construction by the Darbar of a large reservoir at Kannambadi on the river Cauvery and we, therefore, have the honour to submit the following observations for your consideration.

Annexure 1.

2. In 1892 our predecessors, with the concurrence of the Government of India, entered into an agreement with the Mysore Darbar with the object of regulating the construction in Mysore of irrigation works which would affect the supplies to irrigated areas in Madras. Clause IV of this agreement provides that, should there arise a difference of opinion between the Madras and Mysore Governments in any case in which the consent of the former is sought for the construction of an irrigation work, the matter shall be referred to the final decision either of Arbitrators appointed by both Governments, or the Government of India.

Annexure 2.

3. A difference of opinion having arisen in regard to the proposed construction, by Mysore, of a reservoir at Kannambadi on the river Cauvery, Sir Murray Hammick's Government explained to the Government of India (Letter No. 342 I., dated 30th August 1912) why they were unable to give assent to the project and requested that, if the Government of India accepted these reasons, they should inform the Mysore Darbar accordingly, leaving the Government of His Highness the Maharaja, either to acquiesce in this decision or in the alternative to go to arbitration without delay under the agreement of 1892.

Letter No. 53 I., dated 11th January 1913 (*Annexure* 3).

Letter No. 609, Political, dated 22nd January 1913 (*Annexure* 5).

The Government of India in reply stated that they had decided that the matter should be settled by the Arbitration of a tribunal consisting of a High Court Judge, assisted by an Irrigation Expert acting as Assessor. They intimated that the Mysore Darbar was being asked to assent to this, but did not inquire whether the proposal met with the acceptance of the Madras Government. The Darbar stated that they could not accept the proposal if the award given by the Arbitrator was to be final and stipulated that it should be open to the Darbar to place its case before the Government of India after the opinion of the Arbitrator was recorded. The Darbar expressed their preference for inquiry and adjudication by the Government of India but added that, if the Government of India preferred that the matter should form the subject of Arbitration, the Darbar accepted the form of tribunal proposed by the Government of India subject to the right of appeal. The Government of India thereupon without reference to us accepted the conditions proposed by Mysore and appointed Sir Henry Griffin (a Judge of the High Court of the United Provinces) as Arbitrator and Mr. Nethersole (the Inspector-General of Irrigation) as Assessor.

Telegram No. 813 I., dated 22nd June 1913 (*Annexure* 6).

* *Annexure* 1.

† Letter No. 106-O/13-9, dated 6th July 1913 (*Annexure* 7).

4. It is necessary to point out that this Arbitration Tribunal was not appointed under the provisions, or in accordance with the terms, of clause IV of the agreement* of 1892, which have been given in the previous paragraph, and though after a protest† against the procedure adopted, we accepted the tribunal, we did so with a full appreciation o

the fact that it was not a true arbitration tribunal, since it has no power to make an award but could only submit a report and recommendations to the Government of India, who would then pass such orders as they should think suitable after considering the comments on the report offered by the Darbar and ourselves. The point we wish to make is that the orders passed in this matter have been passed by the Government of India acting in their capacity as Supreme Government representative of the Paramount Power and not under clause IV of the agreement of 1892, to which no reference was made by them in the correspondence on the subject; and these orders are therefore open to revision by the Secretary of State in Council. We have good grounds for believing that the Mysore Darbar took the same view as ourselves of the nature of the orders of the Government of India and intended to appeal to you against them if they had supported our objections to the project.

5. In case it should be argued that the agreement of 1892 provided for arbitration and that we have not only had arbitration, but that the Government of India, after hearing our criticisms of the finding of the Arbitrator, have upheld this decision, we wish to point out that, had the Arbitration tribunal been appointed under the terms of the agreement of 1892, its *personnel* would have been different, for we should have taken care that at least one of the Arbitrators was an Irrigation Engineer of high reputation, such as Sir John Benton, well acquainted with the very peculiar conditions of the Cauvery irrigation systems, which differ widely from those found in Northern India or Burma, and even in other parts of this Presidency.

6. The Arbitrator's award appeared to us to be seriously wrong alike on the legal and the engineering issues and we placed before the Government of India a careful and detailed criticism of the various findings. We also replied to the arguments on the other side put forward by the Mysore Darbar and made a lengthy rejoinder to the Darbar's reply to our representations against the award. We expected that the Government of India would deal with the arguments in some detail and give a reasoned decision on the case, but they contented themselves with informing us that after the most careful consideration of the representations from the Mysore Darbar and ourselves, they saw no reason to modify the Arbitrator's award in any respect and were therefore pleased to ratify it. We then begged that they would furnish us with as full a statement as possible of the grounds for their decision to enable us to decide whether we could acquiesce in it, but they have not seen their way to accede to our request and have merely stated in reply that they were satisfied that no evidence had been produced which could be held to show that the original award of the Arbitrator was other than fair and equitable.

Annexure 9.

Annexure 12.

Annexure 14.

Annexure 15 (*a*)

Telegram, dated 26th April 1916 [*Annexure* 15 (*b*)].

Telegram, dated 3rd May 1916 [*Annexure* 15 (*c*)].

7. We believe that our representations disclose most convincing grounds for the amendment of the awards on the various issues, and in view of the great importance of the interests involved and the serious injury which the award will cause to the existing irrigated area of over a million acres in this Presidency, as well as to the area (27,000 acres) in French territories, we are unable to acquiesce in the decision of the Government of India and must refer the matter for your decision.

8. We would moreover point out that the refusal of the Government of India to communicate to us the grounds of their decision hampers us in our present representation, as we are debarred from commenting on the reasons which have led them to reject our arguments and bring them to the conclusion that the award was fair and equitable. The Government of India will no doubt communicate their reasons to you when forwarding this despatch and we venture to suggest that the engineering issues with all the arguments thereon should be submitted to some gentleman of high professional standing for his opinion. We do not propose to trouble you with a recapitulation of our objections to the award, for they are already fully set forth in

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the papers which accompany this letter. We have added a list showing the purport of each paper and an explanatory note to facilitate reference. The last * of them was received by us on the 31st May.

* *Annexure* 19.

9. There are, however, three subsidiary matters to which we wish to invite your special attention. We are assured that when the new irrigation in Mysore develops, serious damage will be done to private proprietors in Tanjore in periods, such as occur three or four times in twenty years, when the river flow is considerably below normal. We apprehend that compensation for any damage and loss caused by the construction and operation of the reservoir under sanction of the Supreme Government could be enforced by civil suit against the Secretary of State. We would, therefore, suggest that if it is finally decided to sanction the construction of the project, it should be made a condition of such sanction that the British Government shall be indemnified by the Mysore Darbar for any damages resulting therefrom for which the Secretary of State may be held liable by the decree of a civil court and for any compensation which may have to be paid to the French Government on account of damages.

Letter from the Government of Madras, to the Hon'ble the Resident in Mysore, No. 431, Revenue, dated 7th May 1900 (*Annexure* 16).

Letter from the Government of Mysore, to the Hon'ble the Resident in Mysore, No. 150-D.C., dated 26th May 1900 (received with the latter's letter No. 2594/302-94, dated 30th May 1900, and printed in G.O. No. 587, Revenue (Confdl. No. 85), dated 18th June 1900 (*Annexure* 17).

There is precedent for such a stipulation in the agreement between the Governments of Madras and Mysore in regard to the construction by the Mysore Government of the Sivasamudram Anicut Power Works on the Cauvery.

10. The second matter is the award system of regulation (Issue 3) which involves serious and unnecessary inaccuracy, in that it provides for forecasting the whole daily flow from a daily measurement of the flow of a catchment which, on the Assessor's computation, yields on an average only 52 per cent of the flow from whole catchment. There are manifest facilities for measuring daily the flow of catchments yielding on an average 85 per cent of the whole, and it is obvious that by adopting this wider basis the liability to error in estimating the total daily flow is greatly reduced. The award system of computation was proposed by neither party and we are left in ignorance of the reasons which led to its adoption.

11. The third point to which we invite your attention is the system to be introduced by the award rules in regard to the limitation of extension of irrigation by Mysore under existing Cauvery channels. It has been represented by both parties that this system is one most difficult to work and containing materials for constant disagreement and dispute between the two Governments. Both Governments are in agreement as to the system on which such extension of irrigation should be limited and have asked that this system involving limitation on a basis of percentage on existing irrigated area, be substituted for the award system.

12. We trust that the mention of these three subsidiary points will not be interpreted as indicating any want of confidence in the validity of our main contention that the quantity of water awarded for Madras irrigation is altogether inadequate and must, in years when the river flow is below the normal, cause serious loss to our ryots as well as to Imperial and Provincial revenues.

13. In conclusion, we wish to assure you that in seeking your intervention we are actuated only by a sense of the great responsibility that rests upon us to safeguard the interests of the ryots who own the vast area of valuable lands in the Cauvery delta. If we can be satisfied that those interests will not be injured, we shall welcome the construction of the Mysore reservoir. But the case is not one which can properly be settled by compromise, unless the Government of India are prepared to compensate the land-owners of the Tanjore district and of that portion of the French possessions which lies in the Cauvery delta. Their interests and claims are based on the right to the continuance of the supplies of water which they have enjoyed from a time long prior to British rule. On the Mysore side, on the other hand, there is no

question of interference with any private rights, for the Darbar's proposals have for their object the creation of new irrigated areas and the interests involved are entirely prospective.

We have the honour to be,

Right Hon'ble Sir,

Your most obedient, humble servants,

PENTLAND.
P. S. SIVASWAMI AYYAR.
HAROLD STUART.
A. G. CARDEW.

OOTACAMUND,
26*th July* 1916.

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ANNEXURES TO DESPATCH No. 1 P.W.D. (IRRIGATION) OF 1916.

(1) Rules defining the limits within which no new irrigation works are to be constructed by the Mysore State without previous reference to the Madras Government (Appendix to G.O. No. 162 I., dated 18th February 1892).

(2) Letter from the Government of Madras to the Government of India, Public Works Department, No. 342 I., dated 30th August 1912.

(3) Letter from the Government of India, No. 53 I., dated 11th January 1913, to the Government of Madras—printed on pages 2–3 of G.O. No. 112 I., dated 2nd March 1914.

(4) Letter from the Hon'ble the Resident in Mysore No. C. 26, dated 1st May 1913, to the Government of India, Foreign Department—printed on pages 3-4 of G.O. No. 112 I., dated 2nd March 1914.

(5) Letter from the Diwan of Mysore to the Hon'ble the Resident in Mysore No. 609-Pol., dated 22nd February 1913—printed on page 4 of G.O. No 112 I., dated 2nd March 1914.

(6) Telegram from the Government of India to the Government of Madras, No. 813 I., dated 2nd June 1913—printed on page 67 of G.O. No. 112 I., dated 2nd March 1914.

(7) Letter from the Government of Madras to the Government of India, No. 106-O/13-9, dated 6th July 1913—printed on pages 4–5 of G.O. No. 455 I., dated 9th August 1913.

(8) Letter from the Government of India to the Government of Madras, No. 1182–1, dated 25th July 1913—printed on page 5 of G.O. No. 455 I., dated 9th August 1913.

(9) Letter from the Government of Madras to the Government of India, Public Works Department, No. 200 I., dated 21st April 1915, with the following accompaniments :—

- (*a*) Note by the Chief Engineer for Irrigation on Issues 2 (*b*), 3 (*a*), 3 (*a*), 3 (*b*) and 4 in three separate parts, with appendices (separate volume).
- (*b*) Memorial of the Tanjore-Trichinopoly district landholders (printed in the latter).
- (*c*) Correspondence with the Governor of French Settlements in India.
- (*d*) Opinion of Mr. S. D. Pears on the Assessor's Examination of Evidence.
- (*e*) Madras Print of Proceedings and Exhibits (four volumes)—
  - (i) Proceedings and Arbitrator's Findings and Award.
  - (ii) Assessor's Examination of Evidence and Assessor's Exhibits.
  - (iii) Madras Exhibits.
  - (iv) Mysore Exhibits. (My. 5 in a bound separate volume—two copies only are sent.)

(10) Mysore Appeal on the Award. (Accompaniment to the Diwan's letter No. 18-Pol., dated 6th July 1915.)

(11) Mysore Print of Proceedings and Exhibits, Volumes I, II and III. (Two sets only are sent. No more copies are available.)

(12) Letter from the Government of Madras to the Government of India, No. 13 I., dated 10th January 1916, and its accompaniment.

(13) Mysore Diwan's letter No. 545-Pol., dated 30th November 1915, and the Mysore Chief Engineer's note of November 1915.

(14) Letter from the Government of Madras to the Government of India, No. 115 I., dated 10th March 1916, and its accompaniment.

(15) (*a*) Letter from the Government of India, No. 082 I., dated 30th March 1916, to the Government of Madras.
(*b*) Telegram to the Government of India, No. T. 5-O, dated 26th April 1916.
(*c*) Telegram from the Government of India, No. 401 I., dated 3rd May 1916.

(16) Letter from the Government of Madras to the Hon'ble the Resident in Mysore, No. 431, Revenue, dated 7th May 1900.

(17) Letter from the Government of Mysore, Public Works Department, to the Hon'ble the Resident in Mysore, No 150-D.C., dated 26th May 1900 (received with the latter's letter No. 1594/302–94, dated 30th May 1900).

(18) Assessor's Exhibit No. A 8 (1) and (2) being volumes I and III of Madras (Mettur) Cauvery Reservoir Project papers.

(19) Mysore Rejoinder to Madras Observations on their appeal (Diwan's letter No. 759-Pol., dated 31st January 1916, and its enclosure received with the Government of India letter No. 441 I., dated 25th May 1916).

EXPLANATORY NOTE.

The Proceedings of the Arbitrator and Assessor and the record of exhibits and pleadings of both sides (all of which were written) have been reprinted both by Mysore and Madras.

Annexure 9 (a) (i) to (iv). 2. The Madras record is in four separate volumes—

(i) The Proceedings of the Arbitrator and Assessor and the Findings and Award of the Arbitrator.

(ii) The Examination of Evidence by the Assessor and the Assessor's Exhibits.

(iii) The Madras Government Exhibits.

(iv) The Mysore Darbar Exhibits.

Annexure 9. The above have been sent already to the Government of India in 1914 before the first appeal representation of the Madras Government (letter No. 200 I., dated 21st April 1915).

Annexure 11. 3. The Mysore record is in three volumes—

Volume I—

The Proceedings of Arbitrator and Assessor.
The Findings and Award of Arbitrator.
The Examination of Evidence by Assessor.
The Assessor's Exhibits.

Volumes II and III—

The Exhibits of both parties consecutively in the order in which they were "put in".

Annexure 10. The above accompanied and were referred to in the Mysore appeal representations accompanying Mysore Diwan's letter No. 18, Political, dated 6th July 1915.

Annexure 12. In the Madras reply to the Mysore representations, the Mysore Print of the Proceedings is generally referred to.

Annexure 13. In the Mysore reply to Madras representations the Darbar give references to their print of Proceedings and not to that of Madras.

Annexure 14. In the Madras Rejoinder for facility of reference the Mysore volumes are referred to; the same Exhibits can, however, be found in the Madras volumes.

Annexure 9 (a).

Annexure 11. The Mysore print does not reproduce some important Exhibits of Madras.

When these are referred to in the Madras reply or Rejoinder, a reference is made to the Madras volumes, but elsewhere the references are for convenience made to the Mysore volumes of Exhibits.

4. The appeal representations consist of—

Annexure 9. I. (a) Madras appeal forwarded to the Government of India with letter No. 200 I., dated 21st April 1915.

Annexure 13. (b) Mysore reply to the above forwarded to the Government of India with Diwan's letter No. 515, Political, dated 30th November 1915.

Annexure 14. (c) The Madras Rejoinder forwarded to the Government of India with letter No. 115 I., dated 10th March 1916.

Annexure 10. II. (i) The Mysore appeal forwarded to the Government of India with Diwan's letter No. 18, Political, dated 6th July 1915.

Annexure 12. (ii) The Madras reply forwarded to the Government of India with letter No. 13 I., dated 10th January 1916.

Annexure 19. (iii) The Mysore Rejoinder forwarded to the Government of India with Diwan's letter No. 759, Political, dated 31st January 1916.

5. The successive representations "put in" and "read" by the parties before the Arbitration Committee with the dates and orders of their reading are noted below.

The other Exhibits were not read, but were put in as evidence supporting the representations or in accordance with the desire of the Arbitrator or Assessor.

Madras Exhibits = (Ma.): Mysore Exhibits = (My.).

Number of exhibits.	Date of reading before Arbitrator.	Madras Print of Proceedings—Madras Exhibits (Ma.). Mysore Exhibits (My.). Arbitrator's Proceedings (A.).	Mysore Print of Proceedings—My. Vols. I, II and III.
Prior to the framing of Issues.			
Ma. 1	17th July 1913	Ma. pages 1–5	My. Vol. II, pages 1–5.
My. 1	21st ,, ..	My. ,, 1–8	,, ,, 7–19.
Proceedings of 21st July 1913 of Arbitrator recording that no oral statements are binding on either party.		A, page 2	My. Vol. I, page 2.
Ma. 3	29th July 1913	Ma. page 13	My. Vol. II, page 39.
My. 4	4th August 1913 ..	My. ,, 21	,, pages 49–69.
Ma. 4	6th ,, .. .	Ma. pages 21–23	,, ,, 71–73.
Proceedings fixing terms of reference.	7th ,, ...	A. ,, 5–6	My. Vol. I, ,, 5–6.
After framing of Issues.			
Ma. 6	21st October 1913	Ma. pages 24–26	My. Vol. II, pages 77–79.
Ma. 7	21st October 1913 to 25th October 1913.	Ma. ,, 29–40	,, ,, 83–96.
Ma. 8		Ma. ,, 43–56	,, ,, 97–113.
Ma. 9		Ma. ,, 129–142	,, ,, 115–130.
Ma. 10		Ma. ,, 143–164	,, ,, 131–155.
My. 6	6th November 1913 to 8th November 1913.	My. ,, 36–40	,, ,, 247–252.
My. 7		My. ,, 40–50	,, ,, 253–266.
My. 8		My. ,, 50–55	,, ,, 267–273.
Ma. 11	27th November 1913 to 29th November 1913.	Ma. ,, 189–192	,, ,, 365–368.
Ma. 12		Ma. ,, 210–228	,, ,, 391–414.
Ma. 13		Ma. ,, 236–242	,, ,, 423–430.
My. 9	16th and 17th December 1913.	My. ,, 128–144	My. Vol. III ,, 433–456.
Ma. 14	6th and 7th January 1914.	Ma. ,, 260–288	,, ,, 489–523.
Ma. 17	8th January 1914 ..	Ma. ,, 303–304	,, ,, 541–542.
My. 12	20th ,, ..	My. ,, 154–169	,, ,, 555–575.
Ma. 18	20th ,, ..	Ma. ,, 306–307	,, ,, 583–584.
My. 13	3rd February 1914 ..	My. page 173	,, page 601.
My. 14		My. ,, 174	,, ,, 603.
My. 15		My. ,, 175	,, ,, 605.
Ma. 22	3rd February 1914 ..	Ma. pages 325–346	,, pages 609–635.
My. 19	18th March 1914 ..	My. ,, 186–195	,, ,, 675–685.
My. 20		My. ,, 196–197	,, ,, 687–689.
Ma. 24	18th March 1914	Ma. ,, 372–377	,, ,, 721–727.
Ma. 25	31st ,, ...	Ma. ,, 385–389	,, ,, 773–780.
My. 22	31st ,, ...	My. ,, 210–215	,, ,, 789–796.
My. 23	9th April 1914 ..	My. ,, 225–231	,, ,, 799–802.
My. 24		My. ,, 232–234	,, ,, 807–811.
Ma. 26	9th April 1914	Ma. ,, 443–446	,, ,, 815–817.
Ma. 27	11th ,, ...	Ma. ,, 448–450	,, ,, 839–841.
My. 28	29th ,, ...	My. ,, 242–244	,, page 851.
My. 30 ..	5th May 1914 ..	My. ,, 244–245	,, pages 852–857.
My. 31		My. ,, 245–248	

6. Before commencing the study of the arguments on the issues involved in the case, it is recommended that the "Historical and Descriptive" part of the case Ma. 8 (My. Vol. I, pages 97 to 113) be perused.

The facts here stated (apart from the arguments) have not been disputed and are accepted by both parties.

It may be noted that the evidence of facts in the case is not generally disputed; it is on the deductions from the facts produced in evidence that the parties differ.

MADRAS EXHIBIT II.

Enquiry into the question of storage of the Cauvery waters within Mysore territory; Mysore-Madras Arbitration, 1913–1914, Volume I (Mysore Print).

(a) Page 81.
(b) Pages 139–143.
(c) Page 86.
(d) ,, 96.
(e) ,, 109.
(f) ,, 116.
(g) ,, 89.
(h) Pages 184–187.
(i) Page 200.
(k) ,, 124.

} Not printed.

MADRAS EXHIBIT III.

Note showing that the question of Mettur Reservoir is not relevant for the purpose of determining the extent of impounding and that there is no difficulty in ascertaining discharges for limit gauges.

The question of the Mettur Reservoir is not at all relevant for the purpose of determining the extent of water Mysore could impound at the Krishnarajasagara. If rule 8 is not there, C will have to be ascertained from time to time: in other words, Mettur or no Mettur, the discharge corresponding to, say 7·5 feet, can always be ascertained. There might be days when, but for the interception at Mettur, water might be flowing, say at 9 feet. One and a half feet might be intercepted at Mettur and the result is 7½ feet on that day at the Cauvery Dam, and that discharge will be the basis of the measurement of the discharge corresponding to 7½ feet. That will determine the quantity above which impounding can be done at the Krishnarajasagara.

When once you know what the discharge corresponding to 7½ feet is, it is perfectly immaterial to Mysore what Madras does with the water corresponding to 7½ feet. Part of it might be intercepted at Mettur, but Mysore will necessarily have the credit of it, because as the result of the formula, there is nothing to prevent Mysore from impounding every drop of water after providing for the 7½ feet out of the natural flow.

That there is no difficulty in ascertaining what would be the discharge for 7·5 feet at the Cauvery Dam under any conditions, is clear from the fact that Mysore is impounding water without giving Madras the actual 7½ feet and yet we are taking gaugings and finding out the discharges equivalent to the different gauges. So long as at any stage you get water at the Cauvery Dam at a height of 7·5 feet or any of the gauges specifically referred to in rule 7, there is no difficulty in finding out the discharges corresponding to those stages.

10*th June* 1929.

A. Krishnaswami Ayyar,
Madras Counsel.

MADRAS EXHIBIT III (*a*).

Interception of water by Mettur and finding out "P".

For the purpose of the working tables of the Krishnarajasagara the examination of which is specified in Rule 11 (ii), it is necessary to ascertain for the 10-year period (1917 to 1926), what would have been the natural flow at the Upper Anicut, if all the waters above the Krishnarajasagara are allowed to flow down without any interception, and to ascertain what would have been the resulting flow, if Mysore had impounded as per the rules contemplated in Rule 11 (ii). Actually during this 10-year period, there has been some partial or full impounding in the Krishnarajasagara. But to arrive at the natural flow at the Cauvery Dam, the form of the working table provides for a certain method being adopted to neutralize the effect of the actual partial or full impounding that may have been made in the Krishnarajasagara—vide columns 5 to 7 in sample Form B. Even if the Mettur reservoir is constructed and it is found necessary to ascertain P, a similar procedure may be adopted to get over the interception of part of the river flow at Mettur.

MADRAS EXHIBIT IV.

Enquiry into the question of the storage of the Cauvery waters within Mysore territory; Mysore Madras Arbitration, 1913-14, Vol. II (Mysore Print), page 191 (not printed).

MADRAS EXHIBIT V.

Extract from Colonel Love's Hydraulics, page 91.

105. *Regime of rivers.*—A river is said to be in a state of *regime* or *stability* when its form changes but little from year to year. Owing to variations of discharge and the consequent erosions and siltings which occur at different seasons of the year, a condition of permanent stability is difficult of attainment; and this is especially the case in Indian rivers which generally have sandy beds, and which are subject to heavy floods.

* * * * *

MADRAS EXHIBIT VI (*a*).

Extract from the Gazetteer of the Tanjore District (published in 1906), Volume I, page 108.

Flood embankments.—There still remain two problems regarding the management of the Cauvery delta. Owing to the fact that the river beds are not much below the level of the plain, and that the fall of the rivers is very gradual, the country would be flooded if high embankments were not raised along all the larger channels. Thus the town of Kumbakonam is mostly below the level of both the Arasalar and the Cauvery rivers which enclose it. It is necessary therefore for the rivers to be well embanked throughout the delta, and for the banks to be constantly looked to. There are upwards of 1,700 miles of such banks, and their maintenance is far from easy. Scarcity of earth and labour, universal encroachment by the ryots and the high value of adjacent land, as well as the shortness of the working season, increase the cost and difficulty. The result is that the banks have not been in the past maintained at a standard height above full supply level. It is still not possible to keep the delta entirely free from the influence of abnormal floods, and when these occur, there is still a danger of breaches and inundation. Proposals are under consideration to provide still further means of disposing of the surplus and it is hoped that these will remove this danger. The strengthening of the Coleroon banks is referred to above. The embankment of the rivers was, it is said, the chief work of the great Karikal Chola (A.D. 50—95); and in the earliest times the country was called the 'land of floods' from the absence or insufficiency of such banks.

MADRAS EXHIBIT VI (*b*).

Extract from the Gazetteer of the Tanjore District published in 1906, *Volume I, pages* 150—153.

The history of the last century bears ample testimony to the danger from floods and cyclones, and the efforts of the Public Works Department have been constantly directed to neutralizing it. The steps taken by them will be found described in chapter IV. A brief account may here be given of the chief disasters that have occurred.

Flood of 1853.—The first flood of which there is any record, occurred in March 1853, and was accompanied by a violent hurricane. An immense volume of water came down the Cauvery, and the river swollen further by heavy local rain, overtopped the banks of the various channels leading from it and covered the greater part of the delta. 'In many places', to use the words of the Collector, 'water stood for some days four and five feet deep over the high roads'. Fortunately there was little or no loss of life; but the destruction of property was great. The roads and the embankments of rivers and channels suffered very severely. The paddy had just been reaped and large quantities which were lying on the threshing floors were either washed away or spoiled. Over 75,000 cattle and nearly 100,000 sheep and goats were drowned, and the wind caused immense destruction of houses and fruit-trees. More than 41,000 houses were destroyed and in Government villages alone over three million fruit-trees were ruined. On the whole the damage was heaviest in the Mannargudi and Tiruturaipundi taluks; in the west and north of the district it was comparatively light, and in Pattukkottai the storm was hardly felt at all. The season prior to the disaster had been unfavourable and the ryots' losses in the two years were computed at over seventeen lakhs of rupees. Remissions of revenue amounting to over two and a half lakhs were granted. At this time the construction of the Tranquebar-Tirumulavasal canal was in contemplation, and the Collector urged its early commencement to provide work for the people who were suffering from high prices. This is the only case of anything resembling a famine work in the history of the district, except those instituted in the great famine of 1876–78.

Hurricane and flood of 1859.—Another hurricane and flood took place in April 1859. Fortunately at this time there was very little grain on the threshing floors, and the damage was consequently confined mainly to the breaching of the river banks and the destruction of houses and trees. At sea the hurricane caused lamentable loss of life and property. More than 30 vessels were wrecked between

Tranquebar and point Calimere. The most serious disaster was the foundering of the British barque *Monarch* with 200 coolies on board. It collided with another vessel and both came ashore, nearly all the coolies being drowned.

Cyclone of 1871.—The next cyclone took place in 1871 on November 6th and 7th. It was more violent on the coast than in the interior and its centre was Tranquebar, where the loss of houses and trees was large. At Negapatam the roof of the railway station was blown off. The rainfall on this occasion however was not particularly heavy (it ranged from 4 inches at Shiyali to 10·6 inches at Kumbakonam) and there seem to have been no losses from floods.

Flood of 1874.—Another high flood occurred in July 1874. On the 16th of that month the water at the Upper Anicut rose to a height that had not been reached for 15 years. Fortunately however the banks of all the rivers in the district had recently received a great deal of attention; the damage done was therefore, comparatively speaking, insignificant.

Flood of 1880.—The consequences of the flood of November 1880 were more serious and resulted in the remission of two and a quarter lakhs of land revenue. Over 29 inches of rain fell in the month of November in the east of the district. The taluk which suffered most was Tirutturaippundi. The flood is said to have been the highest then known. Breaches occurred throughout the delta and the damage done was very great. Roads were destroyed far and wide and several towns were inundated. In Pukulam, a suburb of Tanjore, a whole street of thatched houses was levelled with the ground, 700 houses were destroyed in Tanjore itself, and in the Negepatam taluk the whole village of Muttam was swept away, though the inhabitants managed to save themselves in boats. The Collector described the disaster as a 'complete and utter collapse of the whole Delta Irrigation scheme' and one of its results was that the urgent need for further protection from floods was clearly perceived.

Flood of 1882.—Another but less serious inundation occurred in July 1882. Heavy rains in Mysore and the Nilgiris brought a great flood down the Cauvery, and on the 10th the river began to rise rapidly. The greatest danger was experienced in the town of Kumbakonam. By the afternoon of the 11th, the Arasalar had burst its banks and had spread over a large part of the town, and the most strenuous efforts were needed to prevent the Cauvery from doing the same. The latter river was flowing at a height six inches above that reached in the great flood of 1880. It was estimated that three hundred houses were destroyed in these floods. No lives, however, were lost. Numerous wide breaches occurred in the larger channels throughout the delta, and one of the roads in Tanjore taluk was flooded to the length of a mile and was impassable for ten days. The loss to the ryots was not so great as might have been expected, since the flood occurred in the early part of the cultivation season, and there was time to grow another crop.

Great flood of 1884.—The season of 1884, like that of 1853, was doubly disastrous. The south-west monsoon failed and the north-east rains were unusually heavy. The average rainfall in the east of the district in the months of October, November and December amounted to 66·41 inches, and in Tiruvalur and Nannilam over 21 inches fell in one day (November 3rd). The rain was incessant as well as heavy, so that all the principal and minor rivers in the east burst their banks in all directions. A large number of villages were completely under water for days and even weeks together, and the crops over extensive areas in all the taluks, except Tanjore and Pattukkottai, were destroyed. It was found necessary to remit revenue to the extent of more than six lakhs of rupees. Of this, over a lakh was granted for crops withered from want of water caused by the breaches in the channels. Besides the damage to crops, a great number of houses and trees were destroyed. The taluk which suffered most was Tirutturaippundi where, to use the Collector's words, the damage done to private property was quite incalculable. The floods were followed by cholera, which literally decimated the inhabitants of many of the already impoverished villages.

Floods of 1887, 1891 *and* 1893.—An unusually high flood occurred in the Cauvery delta on the 11th October 1887. New regulators on the Cauvery and

Vennar had however been lately constructed, and they saved Government and the ryots from the serious losses which must otherwise have occurred. The actual damage caused was trifling.

The taluks of Shiyali and Mayavaram were flooded by a deluge of rain at the end of 1891 (without however suffering much harm) and two years later, another flood covered much of the south of the delta. The immediate cause of the latter disaster was a tremendous downpour towards the end of November. In the south of the Pattukkottai taluk, 25 inches fell in 48 hours, and the bunds of the rain-fed tanks, which cover the face of the country, were swept away wholesale. The Vennar breached in several places and wide tracts of country from Tanjore town to the sea were under water for three days. The low parts of Tanjore town were submerged and many people were saved by boats. Near Nidamangalam, half a mile of the railway line was washed away. It was at first apprehended that the loss of crop would be disastrous; but when the water subsided, it was found that the paddy was, generally speaking, little the worse for the immersion. The loss was restricted to fields recently transplanted, or where the grain was in ear, and such areas were fortunately not extensive. The amount of remission granted for land submerged or inundated was under Rs. 6,000 and was confined almost exclusively to the taluks of Shiyali and Tiruturaipundi, which lie at the tail-end of the channels of the delta and always suffer from defective drainage.

Floods of 1896 *and* 1898.—The northern taluks of Kumbakonam, Shiyali and Mayavaram were the scene of floods in July and August 1896. The Coleroon was responsible for most of the damage, having breached its banks in a number of places. Fortunately, cultivation had only just been begun, and comparatively little damage was done. In 1898–99 remissions amounting to Rs. 19,000 were granted in Tiruturaipundi taluk owing to the submersion of 4,000 acres of land.

Hurricane of 1899.—In the next year, on November 12th, a great deal of damage was done by a cyclone. This lasted from 7 or 8 a.m. till about 4 p.m. It was at its worst at midday, when most of the damage was done. In Nannilam taluk it was estimated that Rs. 70,000 worth of property have been destroyed, and the amount of damage done in Negapatam town was calculated at Rs. 1,83,000.

Conclusion.—The last flood of any note was in July and August of 1900. It chiefly affected the Shiyali taluk (in which Rs. 11,000 worth of property was destroyed) and the most serious damage was done by the Coleroon. That river also carried away the great road-bridge on the Madras-Tranquebar main road in November 1903; but, as noted in Chapter VII, this disaster was chiefly due to the bad condition of the bridge.

The above list by no means exhausts the catalogue of calamities of this kind from which the district had suffered. A glance at the statistics of the remissions of revenue which have been granted from time to time, and at the annual jamabandi reports, will show that in almost every year there have been breaches in the river banks, and losses of crops of a more or less serious nature.

MADRAS EXHIBIT VI (*e*).

Extract from the Gazetteer of the Tanjore District (published in 1906*), Volume I, page* 138.

CHAPTER VII.

Page 138—*Bridges.*—The district is very well supplied with bridges, as many as 174 considerable constructions crossing the many rivers which intersect the country. Of these, two call for a particular description. That over the Grand Anicut at the outlet from the Cauvery into the Coleroon, which was built in 1839, consists of thirty arches of 32 feet span. It was adapted to the old native work on which it was built and is accordingly narrow and winding. A finer work was the bridge over the Coleroon (near the Coleroon railway station) on the main road from Madras to Tanquebar, which was carried away by floods in November 1903. It consisted of forty elliptical arches of 50 feet span, measured 2,424 feet from wing to wing and was built in 1855–56. A crack appeared in it during the south-west monsoon in July 1902, which led to an examination of the bridge and the preparation of an estimate for the thorough examination of the flooring. Nothing was,

however, done permanently to better matters and in the August of the next year one of the piers sank slightly. The investigation which followed proved that the bridge was in a dangerous condition. The absence of an apron and a set of the current, caused by a shoal higher up, had led to considerable scouring below the bridge, in some places the floor had entirely disappeared, and two of the archways were badly cracked. Very large repairs were obviously necessary, but before they could be carried out, thirteen of the arches collapsed on November 16th and fourteen more on the following day. Traffic had been prohibited and there was no loss of life. At present communication is kept open by a ferry. It has not yet been decided whether the bridge will be rebuilt or not. The only other bridge across the Coleroon is that which rests on the Lower Anicut in the Kumbakonam taluk.

MADRAS EXHIBIT VII.

Extract from the Gazetteer of the Trichinopoly District, Volume I (published in 1907), pages 193—195.

Floods in 1809, 1817, 1819-20 *and* 1827.—Destructive floods have often visited the district. The first of these of which any record remains, is that of December 1809, when the Cauvery, the Coleroon and the Uyyakondan channel all burst their banks and flooded the whole of the neighbouring tracts. The Collector reported that the country was covered with water as far as the eye could reach, and that even high land was submerged. In consequence of disputes about the commutation prices, the ryots had left large quantities of grain stored on their fields, and the loss caused by the flood was therefore very great.

Another bad flood occurred at the beginning of the cultivation season in 1817, when the Cauvery and the Coleroon burst their banks in no less than 837 places. The value of the crops lost was estimated at four lakhs of rupees and great damage was caused to many of the fields by the sand which the floods deposited upon them. Two years later (1819-20) a still worse flood occurred; 55 villages (chiefly in the then Lalgudi taluk) being completely swept away and their crops totally lost. In Chintamani, one of the suburbs of Trichinopoly, not only were the crops utterly destroyed, but many people were drowned. Both this and the preceding flood were followed by disastrous pestilences. There was another flood in May 1827, but this was due to a hurricane, and most of the damage was caused by breached tanks. The Uyyakondan channel also breached, and in sixteen of the villages under it, no cultivation was possible.

In 1853 *and* 1858.—The next flood took place in March 1853, when a violent hurricane swept over the district, causing great damage to the most important irrigation works and sweeping away thousands of fruit-trees. Numbers of cattle were destroyed and large areas of crops were injured. Advances amounting to Rs. 40,000 were given to the ryots to enable them to carry on cultivation. Five years later (November 1858) the Cauvery came down in the largest flood on record. Not only was the local rainfall very heavy, but while the river was in flood, a cyclone occurred in the neighbourhood of Trichinopoly and a great volume of water entered the Cauvery from the south and the Coleroon from the north. Both rivers breached and their waters spread all over the country, a great quantity passing down into the Tanjore delta. Enormous damage was caused to works of irrigation, tanks, roads and bridges, as well as to standing crops, and many villages were washed away. Fortunately no human life was lost, though sheep and cattle were destroyed in large numbers. Remissions amounting to Rs. 36,000 were granted on account of the destruction of crops. During this flood the water rose to a height of 16 feet at the Cauvery bridge and 13·25 feet at the Cauvery dam.

Recent floods.—Floods of a lesser character have occurred in a number of years since then, and it would be tedious to give detailed accounts of them all. In November 1880 heavy rain and a cyclone caused a number of tanks and channels to breach and burst the banks of the Coleroon, causing great loss of crops and cattle. The damage to irrigation works was estimated at Rs. 78,000 and that to roads at Rs. 30,000. This was followed by a high and prolonged flood in July 1882 which breached the banks of both the Cauvery and the Coleroon. Many houses were destroyed, and several persons were only saved from drowning by the timely arrival of rescuers in boats. The flood lasted from the 6th to the 24th July, and on the

23rd, rose to a height of 13·20 feet on the Cauvery dam. In December 1884 a flood was caused by heavy local rain and high winds. Several jungle streams and channels breached; the Cauvery washed away some of the houses near Trichinopoly; in all, over 1,000 houses were destroyed: the usual loss of crops occurred; and the railway to Erode was breached. A high flood in 1887 (13 feet at the Cauvery bridge) did no harm; but the floods of November 1893 destroyed 1,100 houses near Trichinopoly, the engine-room and store-house of the Trichinopoly works and many acres of crops, and breached the roads and the railway line. The jungle streams and the Uyyakondan channel were the worst offenders on this occasion. A flood in July 1896 was again severe, rising to 13·7 feet at the Upper Anicut. Many breaches occurred both in the Cauvery and the Coleroon; Rs. 40,000 of damage was done to public works, and 25 square miles of country were submerged. Three breaches occurred in the Cauvery and one in the Coleroon in August of the following year, but, comparatively speaking, little harm was caused. In August 1900 the Cauvery was in high flood for some ten days, and several breaches occurred both in its banks and in those of the Coleroon, but again comparatively little harm was done. The last of this catalogue of disasters occurred in 1903. No less than five inundations happened in that year, but they were none of them of any importance except the last, which took place in November. Two or three old breaches opened in the right bank of the Coleroon and one in the left bank of the Cauvery, and several villages in the Srirangam island were partially submerged, many houses were destroyed, and crops were again ruined in considerable quantities.

MADRAS EXHIBIT VIII.

Statement showing water levels and the discharges of the floods of 1896, 1911 *and* 1924 *as given in the Administration Reports.*

Year and date.	Maximum water level.	Maximum discharge.
31st July 1896	13·70 at the Cauvery dam.	313,000 cusecs.
21st July 1911	14·20 do.	478,517 „
20th July 1924	14·65 do.	485,500 „

MADRAS EXHIBIT IX (*a*), (*b*) & (*c*).

Extract from the Administration Report of the Madras Public Works Department (Irrigation) for 1896–97.

Page 11, *Trichinopoly.*—The rainfall during the year was very favourable for cultivation and there were heavy and continued freshes both in the Cauvery and the Coleroon. The first considerable flood which came on in June 1896 reached a height of 221·3 + M.S.L. at the Cauvery bridge gauge and 242·40 + M.S.L. at the Upper Anicut, and the floods which occurred on the 31st July and 1st August 1896 reached a height of 223·22 at the Cauvery bridge and 249·90 at the Upper Anicut above M.S.L. Both were purely river floods, there being no local rain at the time. The flood of 1858, though ¾ feet lower than the last of these at the Upper Anicut, is still the greatest of which there is any record. The river banks were lower then than now and the water spread all over the country, a great portion passing over the Tanjore delta.

Page 13, *Accidents.*—In the Tanjore division, the floods of the year were the highest recorded in the history of the delta, and breaches occurred in the Coleroon river, Muniyar, South Rajan Voikal and Palavar.

In the Negapatam division, leaks in the Koraiyar banks and a small breach in the Morakukarayar channel occurred.

In the Trichinopoly division, during the heavy and abnormal floods of 31st July and 1st August 1896, several breaches occurred in the river and canal banks resulting in 1,672 acres of wet and 174 acres of dry lands being damaged with a loss of revenue to the extent of Rs. 7,595.

Page 35, *General remarks.*—The highest flood of the year was on the 31st July 1896 when the water rose on the gauge of the dam at the head of the Cauvery to 13·7 feet, and at the Cauvery and Vennar regulators to 12·4 feet. The highest flood on record was in 1858, when it rose to 13·25 feet on the gauge at the head of the Cauvery dam.

MADRAS EXHIBIT X.

[*G.O. No.* 1049 *I., dated* 12*th December* 1896.]

Letter from P. R. ALLEN, Esq., Executive Engineer, Trichinopoly division, to the Superintending Engineer, VI Circle, dated Trichinopoly, the 19th October 1896, No. 459-S.E.

I have the honour to submit herewith my report on the late floods in the Cauvery which reached their maximum height on the 31st July last.

2. This was the second considerable flood we have had in the Cauvery during the year 1896, the previous one which reached the height of 221·3 on the Cauvery bridge gauge and 242·40 at the Upper Anicut having occurred on the 26th June. Both these floods were purely river floods, there being absolutely no local rain.

3. As regards the former it will be seen that it is the highest river flood as yet recorded and second only in height to the flood of 1858 which was a combined land and river flood. The records of the 1858 flood are generally discredited, but there is ample evidence to show that it was a considerably higher flood than the late one. From records it would almost appear that the severity of these river floods is progressive. There are, I consider, two reasons for this, the first being that the river is more effectively confined within its banks than formerly and the second that the clearance of the land within the catchment area of the river for cultivation rapidly progresses. Regarding the first of these reasons, I would very strongly recommend that it should not be overrated. I do not suppose that since 1858 so much land has been protected by flood banks as to exert any very great influence on the height of the floods in the river, at any rate above Trichinopoly town. If my reasoning is correct, it would appear that the height of the river floods in the future is likely to continue to be progressive.

4. A statement is attached showing the height the water rose to on 31st July 1896 on various masonry works within this division. I do not propose in this report touching on all the minor details of the damage done by the floods, as what are not here noted are carefully recorded in the accompanying report of the North Subdivision Officer and to which I would refer you. The right bank of the Cauvery all the way down from its head at the junction of the Amaravati to the Cauvery bridge near the Trichinopoly town was found efficient. Two very small areas were flooded in the Kulittalai taluk, one by water finding its way through a disused drainage sluice and the other by water passing up through a drainage bridge on the South Indian Railway, which passes the drainage of the Kulittalai Kattuvari into the Uyyakondan channel.

5. Our difficulties with the set in the 36th mile were aggravated, but a favourably situated accretion has formed, which encourages me to hope that an economical solution of our difficulties is not at all impossible.

6. If you will refer to the taluk map, you will find that an area of 3,500 acres was flooded by water backing up through the Kodamurti bridge. The Kodamurti bridge is an opening left in the flood bank for the discharge of the combined floods of Kodingal drain and Koriar. It is of six segmental arches, 30 feet span, 12·5 feet to springing level. This Koriar and Kodingal together represent the area drained by all cross-drainages of the Uyyakondan from its head to Trichinopoly, and to this must be added the area enclosed between the Uyyakondan and the Cauvery right flood bank—a total area of 512 square miles.

7. From time to time local agitations have been started for works to protect this area liable to submersion by floods. As will be seen above, it is subjected to being flooded by river floods and by land floods. To protect it from river floods it would be necessary to fit up the Kodamurti bridge with shutters. This, however, would certainly not protect it from submersion by land floods and the immense size of any structure fitted up with shutters and of sufficient waterway to pass a land flood, stamps the idea as altogether absurd from a commercial point of view. Again, it has been proposed to so raise the northern bank of the Kodingal drain as to protect the portion between that drain and the river flood bank. Had such been done, it would have protected an area of 1,650 acres from submersion during the late floods. Were such a bank, however, made, it would assuredly be breached during a

land flood, as the opening left for the discharge of the same would be most inadequate. River floods usually occur at a time of year when cultivation has not advanced very far and thus do not do much damage and as there is no practicable manner evident for protecting this area against land floods, I am unable to recommend that any protection work be undertaken.

8. The Kodamurti bund which protects the Trichinopoly town from flooding was eroded by the severe action of the waves. An estimate for raising this bank where necessary and of raising the protecting stone revetment has already been submitted.

9. Below the Cauvery bridge, as far as the old Vennar head, the right bank is used as a road. Here was where I anticipated that most damage would be done, as on a late inspection I found that the surface of this road was for the most part about on a level with the flood of 1893 and which this flood exceeded by two feet. Had this bank breached, very great damage would have been done. In the immediate vicinity several villages would have been flooded and a very great deal of damage done in the Tanjore district. The difficulty, moreover, of stopping such a breach would have been immense, as the water would have found its way into the old Vennar channel and it can only be imagined what would have happened. Here I was aided by a trusty subordinate supervisor, Abdul Latif Sahib, of whom I cannot speak too highly. From the levels now in my office of this road it can be seen the flood was nearly everywhere on a level with its surface and in many places for some distance above it. At one time the water actually began to flow over the bank, but it was stopped in time, small banks erected and the danger averted. In this I consider the supervisor has done substantial service to the Government and I very strongly recommend him for a substantial reward. His great influence also with the Revenue officials of the Trichinopoly taluk was exceedingly advantageous to us elsewhere. The levels of this bank are now in my office and I shall shortly submit an estimate for raising it. In the Srirangam island a bad breach occurred near the head sluice of the Srirangam Nattu Voikal which let the river into this channel. This was caused by two trees which were standing on the bank blowing down. This breach was the cause of partially flooding Srirangam town. It did much damage to the Srirangam Nattu Voikal, but the area flooded by it was not great. I was fortunate enough to secure the services of a company of the IV Pioneers to assist me in closing this breach and through their good work we have now a secure ring bund round it and cultivation under the channel can proceed without hindrance.

10. Both protecting banks of the Srirangam island above the bridge are too low and too small in section. The Cauvery left bank was completely saturated with water and I am surprised it did not go in several places. It leaked badly or rather escaped badly. The height of this bank above the highest flood level differs in places, but in one or two it was barely one foot. Levels of these banks will be taken and estimates submitted for necessary improvements. The road between the bridges is too low. Water actually flowed from the downstream side (to which the flood had uninterrupted access) to the upstream side. I consider that the District Board should be requested to consider the advisability of raising this portion of this road. Below the road, the whole of the island was flooded; water had, as above noted, uninterrupted access to every part of it. The Uthamaseri, Thiruvalarsolai, Thiruplathorai, Kondiampettah, Melur, Kilikudu, etc., were completely swamped and had to be abandoned. Such protecting banks as there are to this part of the island are low and weak and were breached in many portions. It is considered advisable to keep these banks low and weak, as the surplussing facilities from Cauvery to Coleroon are at present insufficient. One of the disadvantages of the land being flooded in this manner is the undesirable deposit which the floods leave on it. I am told this is not generally appreciable, but in the vicinity of breaches it is very great. I have good reason, however, for stating that only a few areas in the whole island have been temporarily rendered uncultivable by this means. Every possible precaution to protect cultivation has been taken.

11. For the opposite side of the river, the North Subdivision Officer has given such ample details of the damage done by the floods in his carefully compiled report

that I have enclosed a copy. It discloses the fact that we must carefully look to our left bank from the head of the river to Musiri as well as at Musiri itself and devise schemes for its improvement.

* * * * * *

No. I-A—Statement of breaches in Musiri taluk.

Name of works.	Locality.	Number of breaches in each work.	Length.	Average depth.
1. Aganda Cauvery left bank	8th mile	1	80	4
	9th ,, ...	2	150	20
	10th ,, ...	3	40	4·5
		4	30	3·5
	11th ,, ...	5	90	3
		6	200	3
		7	90	5
		8	40	3
	13th ,, ...	9	100	8
	22nd ,, ...	10	80	7·5
	23rd ,, ...	11	80	2·5

No. 217 I.

Note by the Chief Engineer for Irrigation.

There has been considerable delay in the submission to this office of the accompanying detailed reports on the Cauvery and Coleroon floods in the Trichinopoly district at the end of July and beginning of August. The reports, however, are very complete and as regards the Coleroon above the Lower Anicut give the information required to fix the proper height of the embankments. The flood line in lower floods was previously known; but the great irregularity in the section of the river made calculations of the level in extreme floods unreliable. The observations made of the flood levels in the Aganda Cauvery and Cauvery are useful as supplementing previous knowledge.

2. The flood of 1882, which was also entirely a Cauvery flood, was lower than that of 1896 by about 9 inches at the Upper Anicut, and 2 feet 2 inches at the Lower Anicut, the great difference being due to the exclusion from the delta, of water in excess of what the rivers could safely carry. This was effected by means of the Cauvery-Vennar regulator, built in 1887. Though not stated in so many words, it has always been recognized that in the event of such a flood as the recent one, it would be right to save the delta by forcing as much water as necessary into the Coleroon at the Grand Anicut. The protection of the delta is not however complete. The right bank of the Coleroon was raised to what was considered the necessary height from the Grand Anicut to the Lower Anicut, a distance of 49 miles, but the project of raising both banks between the Lower Anicut and the sea, a distance of 35 miles, was laid aside owing to the large amount of the estimate, and for other reasons.

3. The Executive Engineer gives a list of breaches in the left bank of the Coleroon. These are chiefly in the bank carrying road No. XX for 13 miles above the Lower Anicut. The whole question of raising the Coleroon banks will be investigated by Lieutenant-Colonel Smart. The difficulty about the left bank between the Upper and Lower Anicuts is that for the whole 66 miles the country to the north, about 1,100 square miles in area, drains into the river. Down to the Nandiyar Anicut, about mile 26, drainage sluices are provided, but below this, there are merely openings in the bund, and whether much would be gained by building sluices in these places is doubtful. Sluices would have to be very large to pass the drainage during heavy land floods, without backing up the water to such an extent as to flood the villages.

4. The flood of 1858, though $\frac{3}{4}$ foot lower than the recent one at the Upper, and $\frac{1}{4}$ foot at the Lower Anicut, is still the greatest, of which there is any record. It began as a Cauvery flood, and during its continuance a cyclone occurred in the neighbourhood of Trichinopoly, and a large volume of water entered the Cauvery from the south and Coleroon from the north. The river bunds were lower then than now, and the water spread all over the country, a great portion passing over the

Tanjore delta. The maximum flood level between Trichinopoly and the Grand Anicut is probably 2 feet higher than the 1896 flood, and the District Board can therefore not be allowed to raise the road forming the Cauvery left bank between those two places, unless large flood openings are left for discharge over Srirangam island to the Coleroon. There may be difficulties in arranging for anything of this sort, as the interested ryots will probably object to having the spill too closely localized. The question of raising the right bank road will also have to be considered in connexion with this.

5. With regard to the embankments of the Srirangam island generally, it is considered inexpedient to strengthen them below Srirangam.

6. The left embankment of the Aganda Cauvery and of the Cauvery above Trichinopoly require to be raised. Estimates for this will be made out.

* * * * * *

1st December 1896.

W. Hughes,
Chief Engineer for Irrigation.

MADRAS EXHIBIT XI.

Extract from the Administration Report for the year 1909–10 *of the Madras Public Works Department (Irrigation).*

Page 17, *Accidents*—12.—The only accident of importance was that which resulted in the collapse of the right abutment and the first two arches of the Grand Anicut.

This was due to the washing out of the sand upon which the under sluice floor was founded and the formation of a cavity which finally led to a blow-up of the floor and the collapse of the first pier. This happened in August 1909 and all that could be done till the end of the irrigation season, was to temporarily make up the breached portion and buttress the end piers. This was done successfully and no inconvenience or loss was caused to the delta irrigation. The work of restoration was begun in December and the abutment and wing and the first two piers were entirely rebuilt on clay foundations 10 feet below crest level. A solid masonry body wall similarly founded was also provided. All this was completed by the beginning of the irrigation season in June and on 8th August 1910 the bridge was reopened for traffic.

MADRAS EXHIBIT XII.

Extract from the Administration Report of the Madras Public Works Department (Irrigation), for the year 1911–12.

Page 6, *paragraph* 13.—The highest floods on record occurred in the Cauvery and Nagavalli rivers, details of which are given below in the statement of important floods of the year :—

River.	Site of anicut.	Highest flood during the year.		Maximum flood recorded.	
		Discharge in cubic feet per second.	Date.	Discharge in cubic feet per second.	Date.
Cauvery ...	Cauvery Dam and Upper Anicut.	378,517	21st July 1911.	313,000	31st July 1896.

* * * * * *

Page 7, *paragraph* 14.— . . . Owing to the abnormal floods in the Cauvery, breaches occurred in several places in the flood banks of the Cauvery and Coleroon in the Tanjore and Trichinopoly divisions.

Page 18, *paragraph* 62.—The floods in the Cauvery were abnormal. There were breaches in the different branches of the river, but none were serious.

MADRAS EXHIBITS XIII & XIII (a)—PLAN.

[Breaches in the Cauvery and Coleroon in July 1911.]

Letter from H. F. DeCourcy, Esq., A.M.I.C.E., Executive Engineer, Trichinopoly division, to the Superintending Engineer, VI Circle, dated 9th August 1911, No. 673-S.E.

[Dis. No. 1487, dated 11th September 1911.]

With reference to your No. 4745, dated 29th July 1911, and No. 4633, dated 26th July 1911, I have the honour to report as follows :—

The water level in the river Cauvery began to rise on the 20th July when the up-stream gauge of the Cauvery at the Cauvery bridge read 8·8′. This had risen to 13·0′ on the morning of the 21st and to 14·3′ on the morning of the 22nd when the flood was at its highest and then began to fall and the gauge was 12·8′ on the 23rd.

2. There were six breaches marked 2, 7, 8, 9, 10 and 11 in sketch [Exhibit XIII (a)] in road No. 5 to the Grand Anicut. These were all below the Tiruvalarsolai surplus channel from the Srirangam Nattu Voikal to the river Cauvery above which there is a proper flood bank for the river Cauvery on the left. The surplus channel mentioned above was ordered by the Superintending Engineer (Mr. Score Smyth) last year to be bunded up as it seldom carried any surplus from the Srirangam Nattu Voikal, whilst when there were freshes in the river, water entered the channel through this surplus course. This cross-bund (marked A) which was thrown up on the right of the bridge (vide sketch accompanying), was washed away by the flood and the water rushed into the Srirangam Nattu Voikal, causing a breach No. 2 in the left bank of the channel, as shown in ~~sketch.~~ This breach is now nearly closed. The next breach No. 7 occurred near B.M. 14, due to the flood water in the Cauvery overflowing the road. This breach will be closed in two or three days. The third breach No. 8 occurred below the old Vennar regulator across the Cauvery, due also to water overtopping the road. This is the most serious breach of the lot, being about 350 feet long. A narrow bank has been thrown across from end to end, so that there may be no delay in raising the supply in the Srirangam Nattu Voikal. The bank here will be made up within a week and protected in front with stakes and bushes against wave action. The remaining three breaches are between the Uthamaseri cross bank and the Grand Anicut and are small and are being closed by the Local Fund department. These are also due to water overflowing the road. Breaches 12 to 16 (vide sketch) are petty breaches in the left bank of the Srirangam Nattu Voikal. These were caused by the water which came over the road through breaches 9 to 11. Nos. 12, 14 and 16 are closed and the remaining two will be closed shortly.

3. In addition to the above, a breach (No. 1) 60 feet long and 12 feet deep occurred in the Timmarayasamudram cross bank and has been closed. Also four breaches Nos. 3 to 5 occurred in the Tiruvalarsolai cross bank. These are 90′ × 4′, 150′ × 4½′, 90′ × 5′ and 90′ × 8′ respectively. These breaches will be ring-bunded for the present as it is difficult to obtain earth at site owing to cultivation. Breaches 1 and 3 to 6 were caused by wave action. There is another breach (No. 17) at the Uthamaseri drainage sluice which was nearly completed when the flood came down. This is a place where breaches occur frequently and on this occasion the water from breaches 2, 7 and 8 and from the Coleroon breaches found an outlet at this place by breaching the bank on both sides of the drainage sluice. Some damage has been done to the drainage sluice, the left front wing and return being swept away, but the exact extent of the damage done cannot be judged till the foundation is unwatered. This will now be done. The wonder is that the sluice was not swept bodily.

4. With the exception of breach No. 17 which was due mainly to the water of the Coleroon river coming down through the breaches above, and breaches Nos. 1 and 2, the remaining breaches would probably not have occurred, if the bank which carries road No. 5 from Tiruvalarsolai surplus course to Grand Anicut had been of sufficient height. Levels are now being taken of this bank and an estimate for raising it as ordered by the Superintending Engineer will soon be submitted.

5. The Cauvery flood banks elsewhere did not breach, but in places there was much danger especially near Murungapettai railway station on the right bank. The bank here has been repaired and strengthened. The Thojakarai bank near Pettavoittalai was also in danger and is being raised and strengthened.

47

6. The Trichinopoly-Karur road between the South Indian Railway at Lalapet and the right flood bank of the Cauvery was nearly overtopped by the water which came in over the Lalapet surplus weir and the road here requires to be raised by the Local Fund department.

MADRAS EXHIBIT XIV.

Letter from the Collector of Trichinopoly, to the Secretary to the Board of Revenue (Settlement), dated 22nd July 1911, No. R.C. 2613-Rev. of 1911.

[*Dis. No.* 1487, *dated* 11*th September* 1911.]

I have the honour to report that since 19th instant there have been heavy floods in the Cauvery. The usual flood telegram from Erode reported 17 feet on the 19th, 24 feet on the 20th and 29·5 feet on the morning of the 21st at the Erode bridge. The latter is, I believe, half a foot above anything previously recorded.

2. A wire has also been received to-day from the Deputy Commissioner, Mysore, that there are unusually heavy floods in the Cauvery.

3. So far, the only actual breaches reported are at Tiruvalarsolai on the north side of Srirangam island and on the south side of the island in two places. The Tahsildar was at the first of these places when the breach occurred and was at the time working with the coolies upon it. I am glad to say no loss of life occurred.

4. The breaches on the south side are said to be endangering the Local Fund road; the Chairman, Srirangam, reports that he is taking what action he can.

5. The Sub-Collector writes of danger of breaches at Timmachipuram and of the complete surrounding of the Padugai village of Korapalayam. All the inhabitants of the latter village were safely removed. He also writes of danger to the main road Kulittalai-Karur, a breach of which might affect villages below. He is on the spot himself doing what can be done.

6. The most serious danger yesterday was at Murungapettai. There was a section of the flood bank there, some 5 or 6 feet lower than the average level. Yesterday morning wires were received that the water was topping it.

7. All day, the Public Works Department officers were working with the aid of a party of men of the 75th Carnatic Infantry kindly lent by the Colonel and a body of 300 or more villagers. When I reached there yesterday evening, the water had reached a height of 3 feet above the level at which the bund had stood in the morning, but the new work was well above the water level and was still being strengthened.

8. A second relay of sepoys arrived at 6-30 p.m. and arrangements were made for fresh coolies at night.

9. A breach of this point would mean the sweeping away of two villages completely as the railway lies only 50 yards behind the flood bank and the two villages lie in the space between. A railway Engineer was at the spot continuously in the interest of the railway.

10. No Erode reports have reached me this morning. I will report later if any further rise is anticipated.

MADRAS EXHIBIT XV.

Extract from G.O. No. 48 I., dated 9th February 1921, *regarding the floods of November* 1920.

Letter from M.R.Ry. G. S. Rama Ayyar Avargal, B.A., B.E., Superintending Engineer, VI Circle, to the Chief Engineer, Public Works Department, No. 170 C.E., dated 29th January 1921.

* * * * * * *

3. The most important of the irrigation sources affected by the November rains is the Uyakondan channel; but the (i) Srirangam Nattu Voikal, (ii) Iyen Peruvalai channel and (iii) the Ponneri channel deserve to be mentioned. The non-mention of the Srirangam Nattu Voikal in the Executive Engineer's letter

No. 1692-E., dated 23rd December 1920, is presumably due to the fact that the affected bank of the channel serves as a flood bank and any damages thereto are included in the damages to the Cauvery flood banks.

4. The breaches that actually occurred in the flood banks of the Cauvery, though costly to make good, are not very serious in themselves, but the erosions caused to the inner slope of the banks are such as to end in disaster unless made good and protected before the freshes of the current year (1921), for which necessary steps have been taken.

* * * * * *

ENCLOSURES

(1)

[Letter from Captain J. O. C. PHELAN, Officiating Executive Engineer, Trichinopoly Division, to the Superintending Engineer, VI Circle, dated the 15th January 1921, No. 93-S.E.]

[*Flood damages.*]

I have the honour to state with reference to your No. 92, dated 5th January 1921, that—

* * * * * *

5. The main entry of the Kondamurti floods have been through the railway bridge and over the railway line for the length of about 1,000 feet. On the Local Fund road the bridge discharged up to the crown of the arches and the floods overtopped the roads and the flood bank 1,000 feet below the pumping station set. There was one breach 80 feet long, at 36/2 opposite to Kambarasampattai village. The next breach was at 600 feet below the pumping station and this is 230 feet long and has breached the road and bank. The third one is the longest and deepest one at the curve 750 feet long through which floods passed for three days. These are all above the bridge and a lump-sum flood damages estimate sanctioned for Rs. 25,000 for restoration is in progress.

6. Below the bridge the floods overflowed for over 300 feet in length at the Tillanayagam Pillai's bathing ghaut (at $38\frac{1}{2}$ B.M. of right bank) damaging two inner walls in the outfall sluices lower down without any damage to the bank.

7. The Srirangam Nattu Voikal has breached its left bank in three places before it crosses over to the right of the road and has inundated rich paddy fields.

8. *The Local Fund road on the left flood bank from its beginning on the Madras Trunk road to Grand Anicut.*—The first three miles of the road is not much affected. Below 3/1, the road has breached in no less than ten places.

9. To cover the damages below the Cauvery bridge and the banks of Srirangam Nattu Voikal a lump-sum estimate for Rs. 21,000 has been sanctioned and is being worked out. So far, there has been no loss of life or property except slight damages to the fields under Srirangam Nattu Voikal.

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MADRAS EXHIBIT XVI.

[Letter from M.R.Ry. M. Nilakanta Ayyar Avargal, Executive Engineer, Trichinopoly Division, to the Superintending, Engineer, Trichinopoly Circle, dated the 8th March 1924, No. 526-S.E.]

[No. 1895/23-*B.E.P., dated 25th April* 1924.]

[*Reference*—Your Nos. 883-T.C., dated 6th September 1923, and 1080-T.C., dated 3rd October 1923.]

During the south-west monsoon floods in the Cauvery, there were four breaches in the flood bank and they are detailed below :—

(1) The breach was about 200 yards above the Uttamaseri bridge, on the left bank. A full report was made in my No. 260-S.E., dated 1st February 1924, and the Chief Engineer's orders were also communicated in Superintending Engineer's No. 255-T.C., dated 15th February 1924. An estimate was sanctioned for Rs. 4,600. The work will be completed within Rs. 3,000. This is a usual breach site and I believe something will soon be done to get a breaching section in the vicinity.

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MADRAS EXHIBIT XVII.

[*Extract from G.O. No.* 299 *I., dated* 22*nd March* 1897.]

Report to accompany the estimate for remodelling the Upper Coleroon Anicut.

	RS.
Amount of estimate	5,34,000

The estimate provides for converting the present anicut or solid weir into an open regulator fitted with moveable gates.

The conversion is desirable on three accounts—

(1) To reduce the amount of sand now being forced down the Cauvery branch and to make the two rivers take a fairly equal share of the sand burden.

(2) To increase the flood discharge of the Coleroon and to decrease that of the Cauvery. At present in floods of over $11\frac{1}{2}$ feet on the Cauvery Dam gauge, there is very considerable spill into the Coleroon over banks and cultivated land, and much damage is caused thereby.

(3) To raise the crest level of the present weir by 2 feet to allow of an increase of supply in the Cauvery during low freshes.

2. In the flood of July-August 1896, the north gauge of the Cauvery Dam on August 1st read 14 feet, which is the hitherto maximum, and was slightly over the great flood of 1858.

By Major Montgomorie's calculation (vide G.O. No. 363 I., dated 9th June 1881) the discharge of such a flood is—

Cauvery	152,000 cubic feet per second
Coleroon	161,000 " "

Of the 152,000 cubic feet per second in the Cauvery, only 102,176 reached the Grand Anicut—

Discharge over	Grand Anicut	62,226
Do.	Cauvery	26,450
Do.	Vennar	13,500
	Total ...	102,176

This leaves 49,824 cubic feet per second spill into the Coleroon by breaches and over road between the two rivers. An approximate calculation made by measuring the lengths of breaches gave a discharge of 64,000 cubic feet per second. The afflux measured just after the flood at the south branch of the Upper Coleroon Anicut, was 2·47 feet It is anticipated that with an open regulator the afflux in a similar flood would not be over one foot, in which case the discharges would be—

Cauvery	119,300 cubic feet per second.
Coleroon	193,700 " "

or the Cauvery will take 32,700 cubic feet less than it did on the 1st August. This would still leave a spill of (48,824 — 32,700) = 16,124 cubic feet per second to be passed into the Coleroon above the Grand Anicut. As this spill is small compared to the spill in the great flood, the question of how the excess is to be provided for, whether by a road dam or otherwise, may be well left for future consideration, and after the effect of the new proposed regulator has been definitely ascertained.

* * * *

A. W. Smart Lieut.-Colonel, R.E.
Superintending Engineer on Special Duty.

28*th January* 1897.

MADRAS EXHIBIT XVIII.

Rules for patrolling the Cauvery banks during high floods, Trichinopoly Division.

1. Both the banks of the Cauvery from Erode down to Grand Anicut are in charge of the Trichinopoly Division and the strength of the conservancy and maintenance establishments is sufficient for ordinary requirements, but when the river runs in high floods, it is necessary to procure a sufficient number of coolies from the villages bordering on the banks for carrying out any urgent protective work for which the assistance of the Revenue Department is required.

2. High floods in the Cauvery almost invariably occur between the 15th July and the 15th August. Heavy rainfall at Mercara of over 3 inches per day for three or four days is usually, but not invariably, an index of high floods and should only be used for giving a warning to flood duty officers to hold themselves in readiness to proceed to their charges.

3. From statistics at present available it is estimated that a reading of 30 feet on the gauge at Dhanakarai indicates a flood of over 11·5 feet at Cauvery Dam about 36 hours later. The gauge readings at Dhanakarai will be wired by the Overseer, Kollegal, on receipt of gauge readings from the special establishment employed, to the Executive Engineer, Trichinopoly Division, as soon as the gauge reaches 30 feet and daily until it falls to 29·5 feet and for every rise and fall of half a foot a special additional wire will be sent until the gauge falls below 30 feet.

The telegrams shall be classed as "Express."

4. The water registrar at Erode will telegraph to the Executive Engineer, Trichinopoly Division, the reading of the Cauvery bridge at Erode when the gauge reads 22·5 feet and if the river continues to rise, he will continue to send telegrams morning and evening giving the gauge readings as observed until the readings fall below 22·0 feet. The telegrams to be sent should be classed as "Express."

5. The following telegraphic or telephonic warnings will be sent by the Executive Engineer, Trichinopoly Division, to the officers noted in the margin :—

Subdivisional Officer, South.
" North.
Section Officer, Trichinopoly taluk.
" " Cantonment.
" Wyacondan.
" Kulittalai.
" Karur.
" Musiri.

First warning.—On receipt of telegraphic report from the Executive Engineer, Cauvery Division, of continuous rainfall at Mercara of an aggregate of above 10 inches in three consecutive days.

Message "Rainfall Mercara indicates flood."—On receipt of this warning, flood duty officers should be in readiness to proceed to their charges and must arrange to be in touch with telegraph or telephone stations.

Second warning.—On receipt of telegram stating that the gauge at Dhanakarai has reached 30 feet or that the gauge at Erode bridge is 22·5 feet.

Message "Flood certain proceed flood duty."—On receipt of this message flood duty officers should proceed at once to their posts and arrange for the vigilant watching of the banks. This warning gives about 24 hours' notice of the arrival of the flood.

* * * * *

Ootacamund, 2nd June 1916.

W. M. Ellis, Colonel, R.E.,
Chief Engineer for Irrigation.

MADRAS EXHIBIT XIX.

Enquiry into the question of the storage of the Cauvery waters within Mysore territory, Volume IV (Mysore print).

(*a*) Page 195 (not printed).
(*b*) Page 196 (not printed).

MADRAS EXHIBIT XX.

Joint Notes on the Joint Mysore-Madras Gaugings of the years 1915 *to* 1921—*Extract from*—.

Page 3—*Paragraph* 7.—Cauvery at the Cauvery Dam.

* * * * *

The conditions are more unstable at this station than at any other at which gaugings have been made. Not only do rapid changes in the bed take place tending to inaccurate gauging, but also the relation between discharge and gauge reading is affected by the existence of a shoal on the Cauvery Dam and by scour taking place round the nose of the island. Conditions may vary considerably in a season and the

general conditions of one season may vary considerably from those of another according to the lengths of the periods for which the Upper Anicut regulator has been opened.

* * * * * *

V. V. PATANKAR,
19—7—22.
Executive Engineer, Cauvery Gauging Division, Mysore.

F. E. MORGAN,
19—7—22.
Executive Engineer, Cauvery Gauging Division, Madras.

MADRAS EXHIBIT XX (*a*)

Joint Note on the Joint Mysore-Madras Gaugings, 1924–25.

Page 16—Portion of the note as the Executive Engineer, Mysore, will have

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As a result of these the average bed level of the river at the Cauvery Dam was lowered by about $1\frac{1}{2}$ feet. The Murungapet breach was closed by about the first week of September and the breach at Kilikkudu by about the 10th of December 1924. From 1st August 1924 till the close of gaugings for the season, viz., 10th of January 1925, the Cauvery Dam existed in breached condition.

* * * * * *

B. KRISHNASWAMI AYYANGAR,
Executive Engineer, Gauging and Regulation Division, Mysore.

19*th July* 1927.

MADRAS EXHIBIT XXI.

Extract of paragraph 2 *of the Note on the Vertical Velocity Observations of* 1919 *at Upper Anicut received with letter No.* 1341/*KSS, dated* 26*th December* 1923, *of the Special Officer, Krishnarajasagara Works* (*No* 241/21 *B.E.P., dated* 3*rd December* 1928).

* * * * * *

2. It may be stated at the very outset that the proportion of the vertical velocity observations to the number of gaugings made at each observation point in all these four years is too small to warrant any reliable conclusions being drawn from the examination of such scanty observations *owing to the peculiar conditions at the Upper Anicut, viz., the formation of shoals and the inconstancy of the bed owing to its being very sandy*, the mean velocities obtained for the same observation point and at the same depth vary considerably and the range of variation in the correction co-efficients obtained from the vertical velocity observations at each station is very wide (vide statement III attached for Price Regular Vertical Velocity Observations of 1919).

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MADRAS EXHIBIT XXII.

CAUVERY DAM.

AVERAGE BED LEVELS—1924.

Current Meter gauging number.	Cauvery Dam, north gauge.	Cauvery Dam, south gauge.	Average water level at Cauvery Dam [columns $\frac{(2)+(3)}{2}$ + 236·24.]	Site north gauge water level.	Site south gauge water level.	Average water level at gauging section [columns $\frac{(5)+(6)}{2}$.]	Average surface fall [columns (4) — (7).]	Area of water way at gauging section.	Width at gauging section.	Mean depth of flow at gauging section [columns (9) ÷ (10).]	Average bed level at gauging section [columns (7) — (11).]	Average bed level at Cauvery Dam [columns (4) — (11) or columns (8) + (12).]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1	6·24	6·03	242·38	241·88	242·10	241·99	0·39	9,054	1,995	4·64	237·45	237·84
2	6·15	5·95	242·29	241·84	242·05	241·95	0·34	9,168	1,995	4·60	237·35	237·69
3	5·39	5·18	241·53	241·01	241·31	241·16	0·37	7,629	1,992	3·83	237·33	237·70
4	5·12	4·92	241·26	240·73	241·04	240·89	0·37	6,989	1,991	3·51	237·38	237·75
‡												
19	5·30	5·16	241·47	241·07	241·06	241·07	0·40	7,021	1,993	3·52	237·55	237·95
20	7·84	7·72	244·02	243·67	243·89	243·78	0·24	12,773	2,013	6·35	237·43	237·67
21	7·25	7·14	243·44	243·07	243·30	243·19	0·25	11,175	2,005	5·57	237·62	237·87
22	9·47	9·22	245·59	245·24	245·45	245·35	0·24	15,329	2,025	7·57	237·78	238·02
23	7·68	7·70	243·93	..*	..*	..	..	14,553	1,984	7·34	..	236·59
24	7·11	6·99	243·29	..	..	..	..	13,273	1,981	6·70	..	236·59
25	6·41	6·20	242·55	..	..	..	..	11,757	1,974	5·96	..	256·59
26	5·88	5·55	241·96	..	..	..	..	10,515	1,972	5·33	..	236·63
27	6·73	6·52	242·87	242·37	† *242·71*	242·54	0·33	12,381	1,976	6·27	236·27	236·60
28	6·57	6·36	242·71	242·12	*242·46*	242·29	0·42	12,033	1,976	6·09	236·20	236·62
29	6·97	6·82	243·14	242·50	242·84	242·67	0·47	13,113	1,984	6·61	236·06	236·53
30	7·22	7·09	243·40	242·80	243·09	242·95	0·45	13,640	1,988	6·86	236·09	236·54
31	7·84	7·90	244·11	243·61	243·98	243·80	0·31	15,482	1,990	7·78	236·02	236·33
32	7·60	7·54	243·81	243·31	243·66	243·49	0·32	14,910	1,987	7·50	235·99	236·31
33	7·38	7·31	243·59	243·04	243·45	243·25	0·34	14,660	1,984	7·39	235·86	236·20
34	7·63	7·65	243·88	243·29	243·75	243·52	0·36	15,433	1,988	7·76	235·76	236·12
35	7·10	7·00	243·29	242·70	243·11	242·91	0·38	14,047	1,975	7·11	235·80	236·18
36	6·61	6·51	242·80	242·18	242·56	242·37	0·43	12,904	1,975	6·53	235·84	236·27
37	6·01	5·79	242·14	241·46	241·82	241·64	0·50	11,407	1,973	5·78	235·86	236·36
72	5·60	5·62	241·85	241·23	*241·87*	241·55	0·30	9,210	1,987	4·64	236·91	237·21

* Gauge readings not available, as the site gauges were washed away.

† Figures in italics have been interpolated with reference to known readings of the other site gauge, the corresponding readings of this gauge not being available.

‡ Gaugings not included in this statement have been omitted as they are for stages when shoals in the bed at gauging site are exposed and it is not therefore possible to work out the average bed levels from the recorded soundings.

CAUVERY DAM.

AVERAGE BED LEVELS—1925.

Current Meter gauging number.	Cauvery Dam, north gauge.	Cauvery Dam, south gauge.	Average water level at Cauvery Dam [columns $\frac{(2)+(3)}{2}$ + 236·24].	Site north gauge water level.	Site south gauge water level.	Average water level at gauging section [columns $\frac{(5)+(6)}{2}$.]	Average surface fall [columns (4) − (7)].	Area of water way at gauging section.	Width at gauging section.	Mean depth of flow at gauging section [columns (9) ÷ (10)].	Average bed level at gauging section [columns (7) − (11)].	Average bed level at Cauvery Dam [columns (4) − (11) or columns (8) + (12)].
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
1	5·95	6·07	242·25	242·01	241·93	241·97	0·28	11,278	2,004	5·63	236·34	236·62
2	5·53	5·61	241·81	241·60	241·49	241·55	0·26	10,670	2,000	5·34	236·21	236·47
3	5·04	5·08	241·30	241·11	240·91	241·01	0·29	9,723	1,997	4·87	236·14	236·43
4	4·80	4·83	241·06	240·88	240·68	240·78	0·28	9,164	1,995	4·59	236·19	236·47
5	4·09	4·27	240·42	*240·38*	240·10	240·24	0·23	8,216	1,993	4·12	236·12	236·30
†												
10	6·35	6·64	242·74	242·40	**242·44*	242·42	0·32	12,716	2,008	6·33	236·09	236·41
11	7·71	8·04	244·12	243·87	*243·94*	243·91	0·21	15,599	2,019	7·73	236·18	236·39
12	8·85	9·23	245·28	244·99	*245·10*	245·05	0·23	17,595	2,033	8·65	236·40	236·63
13	9·48	9·78	245·87	245·64	*245·78*	245·71	0·16	18,730	2,038	9·19	236·52	236·68
14	9·48	9·65	245·81	245·51	245·69	245·60	0·21	17,783	2,036	8·73	236·87	237·08
15	9·24	9·49	245·61	245·33	245·53	245·43	0·18	17,652	2,000	8·83	236·60	236·78
16	9·04	9·28	245·40	245·08	245·31	245·20	0·20	17,587	2,027	8·68	236·52	236·72
17	8·50	8·81	244·90	244·61	244·85	244·73	0·17	16,979	2,024	8·39	236·34	236·51
18	7·92	8·14	244·27	243·93	244·18	244·06	0·21	15,388	2,020	7·62	236·44	236·65
19	7·15	7·35	243·49	243·13	243·38	243·26	0·23	13,740	2,015	6·82	236·44	236·67
20	6·80	7·16	243·22	242·91	243·18	243·05	0·17	13,146	2,016	6·52	236·53	236·70
21	6·80	6·97	243·13	242·66	242·99	242·83	0·30	12,799	2,013	6·36	236·47	236·77
22	6·37	6·43	242·64	242·09	242·45	242·27	0·37	11,591	2,013	5·76	236·51	236·88
23	5·38	5·31	241·59	241·02	241·35	241·19	0·40	9,447	1,999	4·73	236·46	236·86
24	5·05	4·93	241·23	240·72	240·96	240·84	0·39	8,869	1,999	4·44	236·40	236·79
25	4·90	4·80	241·09	240·63	240·82	240·73	0·36	8,724	1,999	4·36	236·37	236·73
26	5·19	5·12	241·40	240·96	241·12	241·04	0·36	9,387	2,000	4·69	236·35	236·71
27	4·91	4·82	241·11	240·67	240·79	240·73	0·38	8,662	1,999	4·33	236·46	236·78
28	5·19	5·13	241·40	240·99	241·08	241·04	0·36	9,162	2,002	4·58	236·46	236·82
29	5·54	5·52	241·77	241·36	241·41	241·39	0·38	9,500	2,005	4·74	236·65	237·03
30	6·00	6·15	242·32	241·92	242·00	241·96	0·36	10,626	2,009	5·29	236·67	237·03
31	5·44	5·53	241·73	241·34	241·37	241·36	0·37	9,963	2,002	4·98	236·38	236·75
32	4·33	4·27	240·54	240·19	240·09	240·14	0·40	7,615	1,997	3·81	236·33	236·73
33	5·02	4·99	241·25	240·83	240·80	240·82	0·43	8,993	2,000	4·50	236·32	236·75
34	5·50	5·58	241·78	241·33	241·37	241·35	0·43	10,082	2,004	5·03	236·32	236·75
35	5·64	5·78	241·95	241·50	241·56	241·53	0·42	10,627	2,005	5·30	236·23	236·65
36	5·79	5·97	242·12	241·64	241·75	241·70	0·42	11,055	2,007	5·51	236·19	236·61

* Figures in italics have been interpolated with reference to known gauge readings of the other site gauge, the corresponding readings of the gauge not being available.

† Gaugings not included in this statement have been omitted as they are for stages when shoals in the bed at gauging site are exposed and it is not therefore possible to work out the average bed levels from the recorded soundings.

CAUVERY DAM.

AVERAGE BED LEVELS—1925—*cont.*

Current-Meter gauging number. (1)	Cauvery Dam, north gauge. (2)	Cauvery Dam, south gauge. (3)	Average water-level at Cauvery Dam [*columns* $\frac{(2)+(3)}{2}$ + 236·24.] (4)	Site north gauge water level. (5)	Site south gauge water level. (6)	Average water level at gauging section [*columns* $\frac{(5)+(6)}{2}$] (7)	Average surface fall [*columns* (4) − (7)] (8)	Area of water way at gauging section. (9)	Width at gauging section. (10)	Mean depth of flow at gauging section [*columns* (9) ÷ (10)]. (11)	Average bed level at gauging section [*columns* (7) − (11)]. (12)	Average bed level at Cauvery Dam [*columns* (4) − (11) or *columns* (8) + (12)]. (13)
37	5·63	5·78	241·95	241·47	241·57	241·52	0·43	10,558	2,005	5·27	236·25	236·68
38	5·12	5·12	241·36	240·79	240·95	240·87	0·49	9,250	2,001	4·62	236·25	236·74
39	4·55	4·53	240·78	240·28	240·37	240·33	0·45	7,974	1,999	3·99	236·34	236·79
40	4·24	4·22	240·47	239·95	240·07	240·01	0·46	7,379	1,996	3·70	236·31	236·77
41	4·24	4·18	240·45	239·93	240·04	239·99	0·46	7,430	1,998	3·72	236·27	236·73
42	4·00	3·97	240·23	239·62	239·85	239·74	0·49	6,975	1,996	3·49	236·25	236·74
43	3·96	3·95	240·20	239·75	239·83	239·79	0·41	6,939	1,997	3·47	236·32	236·73
44	4·36	4·40	240·62	240·16	240·28	240·22	0·40	7,989	1,999	3·99	236·23	236·63
45	5·18	5·25	241·46	240·98	241·11	241·05	0·41	9,610	2,003	4·80	236·25	236·66
46	5·10	5·12	241·35	240·86	241·01	240·94	0·41	9,457	2,003	4·71	236·23	236·64
47	4·93	4·92	241·17	240·70	240·80	240·75	0·42	8,822	2,002	4·41	236·34	236·76
48	5·19	5·22	241·45	241·06	241·11	241·09	0·36	9,381	2,005	4·68	236·41	236·77
49	5·86	5·99	242·17	241·76	241·85	241·81	0·36	10,728	2,010	5·33	236·48	236·84
50	6·91	7·13	243·26	242·92	*242·96* *	242·94	0·32	12,966	2,019	6·42	236·52	236·84
51	7·05	7·24	243·39	243·04	*243·05*	243·05	0·34	13,300	2,019	6·59	236·46	236·80
52	7·13	7·31	243·46	243·19	243·17	243·18	0·28	13,620	2,019	6·75	236·43	236·71
53	7·10	7·25	243·42	243·15	243·15	243·15	0·27	14,170	2,020	7·01	236·14	236·41
54	6·25	6·35	242·54	242·20	242·25	242·23	0·31	12,348	2,012	6·13	236·10	236·41
55	5·20	5·24	241·46	241·19	241·31	241·25	0·21	10,077	2,004	5·03	236·22	236·43
56	4·96	4·96	241·20	240·95	240·92	240·94	0·26	9,795	2,004	4·89	236·05	236·31
57	4·52	4·61	240·81	240·63	240·56	240·60	0·21	9,000	2,002	4·50	236·10	236·31
58	4·12	4·23	240·42	240·29	240·21	240·25	0·17	8,345	2,002	4·17	236·08	236·25
59	3·90	4·03	240·21	240·09	240·02	240·06	0·15	8,015	1,998	4·01	236·05	236·20
60	3·62	3·72	239·91	239·80	239·71	239·76	0·15	7,542	1,997	3·78	235·98	236·13
61	3·52	3·62	239·81	239·73	239·62	239·68	0·13	7,371	1,995	3·69	235·99	236·12
72	3·35	3·41	239·62	239·56	239·33	239·45	0·17	6,843	1,993	3·43	236·02	236·19
73	3·44	3·55	239·74	239·70	239·46	239·58	0·16	7,076	1,996	3·55	236·03	236·19
74	3·22	3·14	239·42	239·29	239·09	239·19	0·23	6,296	1,990	3·16	236·03	236·26
75	3·68	3·85	240·01	239·99	239·78	239·89	0·12	7,731	1,998	3·87	236·02	236·14
76	5·13	5·18	241·40	241·13	241·19	241·16	0·24	10,277	2,008	5·12	236·04	236·28
77	5·44	5·47	241·70	241·35	241·24	241·30	0·40	10,744	2,007	5·35	235·95	236·35
78	4·44	4·58	240·75	240·50	240·37	240·44	0·31	9,009	2,000	4·50	235·96	236·27
79	3·93	4·10	240·26	240·06	239·91	239·99	0·27	8,050	1,999	4·03	235·96	236·23
80	3·76	3·98	240·11	239·94	239·74	239·84	0·27	7,743	1,996	3·88	235·96	236·23
81	3·31	3·50	239·65	239·39	239·24	239·32	0·33	6,728	1,992	3·38	235·94	236·27
82	3·07	3·12	239·34	238·97	238·84	238·91	0·43	5,459	1,990	2·74	236·17	236·60

* Figures in italics have been interpolated with reference to known gauge readings of the other site gauge the corresponding readings of the gauge not being available.

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EXHIBIT XXII (*a*).

Note on average bed levels.

The average bed level of the river at the Cauvery Dam has not gone below the crest level in 1924 during the periods of gauging.

According to the blue print furnished by Mysore (Exhibit Q) the average bed level at the Current Meter section immediately after the flood, that is, on 6th August 1924, was 236·15. The bed fall between the Cauvery Dam and Current Meter section is ·50—vide Volume IV, page 350, paragraph 140, the bed fall being about 3 feet per mile. Therefore if you add ·50 to 236·15, you get the average bed level at the Cauvery Dam, and that is 236·65, which is above 236·24, the crest level of the dam.

The fact that the bed fall between the Cauvery Dam and the gauging section is ·50 is also borne out by the sketch A furnished by Mysore along with the statement of their case.

The distance between the Cauvery Dam and the Grand Anicut is 18 miles and the difference in level between the two places is about 52 feet. Therefore for a distance of 900 feet between the Cauvery Dam and the gauging section the bed fall will work out to ·50 foot.

2 According to the third blue print furnished by Mysore (Exhibit Q-2), the difference of the two levels at the Current Meter section between the pre-breach and the post-breach period, that is between 16th July 1924 and 6th August 1924, is 1·44 or roughly 1·5. This fact is further corroborated by the statement of the Mysore Executive Engineer at page 16 of the joint gauging reports of both Madras and Mysore. The level at the Cauvery Dam on 16th July 1924 was 238·02—vide Madras Exhibit XXII, C.M.G. No. 22 of 1924. Therefore if you deduct 1·5 from this figure, you get 236·52 which is above the crest level of the Cauvery Dam.

Or again, take the figure for the bed level at the Cauvery Dam during the summer of 1923–24, viz., 238·33. Taking that the bed level continued at that figure up to the irrigation season, the bed level at the Cauvery Dam after the flood would be 238·33 *minus* 1·5 which is above the crest level. Of course you are assuming that the variation in the bed level between the periods just prior to the flood and subsequent to the flood is the same as at the Current Meter section.

3. There is a third method furnished by the statement filed by Madras (Exhibit XXII) and that is by working out the difference between the water level at the Cauvery Dam and the water level at the Current Meter section. The difference in the water levels would roughly represent the difference in the bed levels.

Column 4 of the statement denotes the water level at the Cauvery Dam on the days referred to under column 1.

Column 7 gives the corresponding water level at the Current Meter section.

The difference between the two columns gives the corresponding surface fall, i.e., column 8.

Column 9 denotes the area of water way at the gauging section arrived at by joint gaugings.

Column 10 gives the corresponding agreed width at the gauging section.

Dividing the area of the water way by the width at the gauging section, you get the mean depth of flow at the gauging section and that is shown in column 11.

If you deduct the mean depth of flow at the gauging section so arrived at from the water level at the gauging section, you get the corresponding average bed level at the gauging section and that is represented by column 12.

If to the bed level at the gauging section, i.e., column 12, you add the corresponding surface fall given in column 8 which may be taken to represent the bed fall also, you get the corresponding average bed level at the Cauvery Dam (column 13).

It may be mentioned that the water level at the Cauvery Dam and at the gauging section is taken to be the mean of the two readings of the gauges on either side and this method is according to Bellasis the right method. Bellasis, page 301.

11*th June* 1929.

A. Krishnaswami Ayyar,
Madras Counsel.

MADRAS EXHIBIT XXII (*b*).

Bellasis—Hydraulics with working tables—4th Edition—page 301.

* * * * *

"The slope should, unless the stream is perfectly uniform and straight, be observed at both banks and the mean taken."

MADRAS EXHIBIT XXII (*c*).

Bellasis—Hydraulics (4th Edition) with working tables—Extracts from.

Page 36.—It is well known that the scouring and transporting power of a stream increases with its velocity.

Page 36.—A stream of given velocity and depth can only carry a certain charge of silt. When it is carrying this it is said to be fully charged.

Page 37.—If a stream is not fully charged, it tends to become so by scouring its bed.

Page 38.—When the velocity of a stream is arrested altogether, as it practically is when a stream flows through a large reservoir, the whole of the silt will deposit if it has time to do so, that is, if the reservoir is large enough.

MADRAS EXHIBIT XXII (*d*).

Bellasis "Hydraulics with working tables", page 195—Rugosity (Not printed).

MADRAS EXHIBIT XXII (*e*).

Bellasis "Hydraulics with working tables", page 279—Drop-Down curve (Not printed)—Curve shown to the Arbitrator.

MADRAS EXHIBIT XXII (*f*).

Abstract statements of discharges at the Cauvery Dam gauging station at the Upper Anicut from 1917 to 1926 (Printed separately).

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MADRAS EXHIBIT XXIII.

CAUVERY DAM DISCHARGES.

Cauvery Dam North Gauge.	1909.	1917.	1918.	1919.	1920.	1921.	1922.	1923.	1924.		1925.	1926.	Average of		
									† Before floods.	‡ After floods.			3 years	$7\frac{1}{4}$ years.	10 years.
3·0	4,200	* (5,640)	5,640	7,230	5,930	4,760	4,250	4,030	5,530	10,100 (9,190)	10,800	7,770	6,170	5,380	6 520
3·5	5,400	* (8,490)	8,440	9,860	7,950	6,510	6,710	5,700	7,520	13,400 (12,200)	14,500	10,700	8,930	7,650	9,110
4·0	6,600	11,500	11,500	12,700	10,400	8,860	9,550	7,670	10,000	17,100 (15,700)	18,300	13,900	11,900	10,300	12,000
4·5	8,150	14,300	14,800	15,600	13,200	11,800	12,500	9,910	12,600	20,900 (19,200)	22,200	17,800	14,900	13,100	15,100
5·0	11,200	17,400	17,800	18,700	16,300	15,200	16,400	12,500	15,500	25,200 (23,300)	26,200	22,400	18,000	16,100	18,500
5·5	15,100	20,900	20,800	22,000	19,800	18,600	19,200	15,600	19,000	30,300 (28,000)	31,100	28,000	21.200	19,500	22,400
6·0	18,750	24,800	24,300	26,000	24,000	22,800	23,700	19,500	23,100	35,900 (33,300)	37,000	33,700	25,000	23,500	26,900
6·5	22,750	29,200	29,800	30,400	28,500	27,500	28,200	25,000	28,200	41,900 (39,200)	43,000	39,500	29,800	28,400	32,000
7·0	26,500	34,200	35,500	35,300	33,200	32,200	32,800	32,100	33,900	48,800 (45,800)	49,100	45,300	35,000	33,770	37,600
7·5	33,250	39,500	* (41,000)	40,200	38,100	37,700	37,800	39,300	39,300	56,600 (53,100)	55,400	51,100	40,200	39,100	43,300

* Accepted table does not give figures; hence deduced from five years' average accepted figures

† Applicable for a period of $1\frac{1}{2}$ months from 1st June to 16th July 1924.

‡ Applicable for a period of six months from 1st August 1924 to 31st January 1925.

The figures in brackets for 1924 for each guage are $\frac{(4 \times \text{discharge after floods} + \text{discharge before flood})}{5}$.

MADRAS EXHIBIT XXIV (*a*), (*b*), (*c*).

Cross-sections of the Cauvery at the Cauvery Dam for ten years (to show variations in consecutive years) plotted from summer charts. (Not printed).

MADRAS EXHIBIT XXV.

(*Strange—" Irrigation, Roads and Buildings* ", *page* 61.)

Relation between velocity and scour.—The scouring power of water tends to overcome the resistance due to cohesion, and varies as the square of the velocity of the current; the transporting power of water tends to overcome the resistance due to weight, and varies as the sixth power of that velocity.

MADRAS EXHIBIT XXV (*a*).

(*Strange—" Irrigation, Roads and Buildings* ", *pages* 333–34.)

Velocity.—

(ii) The velocity depends greatly upon the depth.

(v) When the velocity is retarded, silt is dropped; when the velocity is increased, silt is picked up.

(vii) A deep channel scoured out during the flood season may silt up in the succeeding low-water season, as its section will be too great for the reduced velocity then. In the following flood season, the silting will at first reduce the velocity below what it was in the previous one; but if the floods continue sufficiently long and are sufficiently intense, they will scour away the deposit and re-establish the former deep channel. If, however, for any reason the floods are decreased and last only for a short time, they may not have sufficient power to scour, and the silting up may remain permanently, and thus affect the flood regime of the river.

MADRAS EXHIBIT XXVI.

(*Ellis—" Irrigation Manual* ", *page* 75.)

Eroding power of clear water.—As flow at a certain velocity and depth connotes power of transportation of a certain percentage of silt of certain quality it follows that where a canal, flowing at a velocity which will transport a proportion (p) of silt to water, is supplied at the head with water with a less proportion of silt, there will be a tendency to pick up and transport from the canal bed or margins the balance of silt required to make up this proportion. It is found that this takes place and that silt deposited in the upper reaches of canal when river waters are heavily charged with silt, is picked up and carried forward when the river water becomes clear . . . Thus a canal which may not scour with silty water may do so with clear water flowing at the same depth and velocity.

MADRAS EXHIBIT XXVII.

(*Russell—" River Development* ", *page* 21.)

An increase in the volume of a stream increases its ability to transport. The greater the volume of a stream, the greater will be its velocity, and the less its loss of power due to friction in proportion to its energy. Here, again, the increase in transporting power is greater than a simple ratio.

MADRAS EXHIBIT XXVIII.

Statement showing the number of days on which there was a flood of 11½ feet and over at the Cauvery Dam North Gauge.

		6 A.M.	6 P.M.
1896 ...	... 28th July ...	...	11·7
	29th " ...	12·3	12·7
	30th " ...	13·0	13·7
	31st " ...	13·8	13·4
	1st August ...	13·3	14·0
	2nd " ...	13·5	13·0
	3rd " ...	12·5	12·1
	4th " ...	11·7	11·7

28th July, 6 p.m., to 4th August, 6 p.m., i.e., 7 days.

Statement showing the number of days on which there was a flood of 11½ feet and over at the Cauvery Dam North Gauge—*cont.*

			6 A.M.	6 P.M.
1911 ...	... 20th July	... ...	...	11·5
	21st „	... ...	13·1	13·7
	22nd „	... ...	13·6	12·7
	23rd „	... ...	12·0	11·6

20th July, 6 p.m., to 23rd July, 6 p.m., i.e., 3 days.

			6 A.M.	6 P.M.
1924 ...	... 17th July	... ...	12·65	14·10
	18th „	... ...	14·44	14·40
	19th „	... ...	14·10	14·49
	20th „	... ...	14·65	14·36
	21st „	... ...	14·00	13·80
	22nd „	... ...	13·15	12·80
	23rd „	... ...	12·30	12·60
	24th „	... ...	12·93	12·31
	25th „	... ...	12·70	13·40
	26th „	... ...	14·00	14·40
	27th „	... ...	14·51	14·61
	28th „	... ...	14·45	13·91
	29th „	... ...	12·93	12·20
	30th „	... ...	11·50	...

17th July, 6 a.m., to 30th July, 6 a.m., i.e., 13 days.

MADRAS EXHIBIT XXIX.

CAUVERY DAM DISCHARGES.

Discharges of 1909 *and* 1917 *to* 1926 *and the averages of* 3, 7¼ *and* 10 *years as percentages of* 1919 *discharges.*

Cauvery Dam North Gauge.	1909.	1917.	1918.	1919.	1920.	1921.	1922.	1923.	1924.		1925.	1926.	Average of		
									Before floods.	After floods.			3 years.	7¼ years.	10 years.
3·0	58·1	78·0	78·0	100·0	82·0	65·8	58·8	55·7	76·5	139·7	149·4	107·5	85·8	74·4	90·2
3·5	54·8	86·1	85·6	100·0	80·6	66·0	68·1	57·8	76·3	135·9	147·1	103·5	90·6	77·6	92·4
4·0	52·0	90·6	90·6	100·0	81·9	69·8	75·2	60·4	78·7	134·6	144·1	109·4	93·7	81·1	94·5
4·5	52·2	91·7	94·9	100·0	84·6	75·6	80·1	63·5	80·8	134·0	142·3	114·1	95·5	84·0	96·8
5·0	59·9	93·0	95·2	100·0	87·2	81·3	82·4	66·8	82·9	134·8	140·1	119·8	96·3	86·1	98·9
5·5	68·6	95·0	94·5	100·0	90·0	84·5	87·3	70·9	86·4	137·7	141·4	127·3	96·4	88·6	101·8
6·0	72·1	95·4	93·5	100·0	92·3	87·7	91·2	75·0	88·8	138·1	142·3	129·6	96·2	90·4	103·5
6·5	74·8	96·1	98·0	100·0	93·8	90·5	92·8	82·2	92·8	137·8	141·4	129·9	98·0	93·4	105·3
7·0	75·1	96·9	100·6	100·0	94·1	91·2	92·9	90·9	96·0	138·2	139·1	128·3	99·2	95·5	106·5
7·5	82·7	98·3	102·0	100·0	94·8	93·8	94·8	97·8	97·8	140·8	137·8	127·1	100·0	97·3	107·7

MADRAS EXHIBIT XXIX (*a*), (*b*), (*c*).

XXIX. (*a*) Diagram showing the agreed discharges of each year (1909 and 1917 to 1926) expressed as a percentage of the 1919 discharge for 3·0 feet reading on the Cauvery Dam North Gauge. (Not printed.)

XXIX. (*b*) Diagram showing the agreed discharge of each year (1909 and 1917 to 1926) expressed as a percentage of the 1919 discharge for 3·5 feet reading on the Cauvery Dam North Gauge. (Not printed.)

XXIX. (*c*) Diagram showing the agreed discharges of each year (1909 and 1917 to 1926) expressed as a percentage of the 1919 discharge for 7·5 feet reading on the Cauvery Dam North Gauge. (Not printed.)

MADRAS EXHIBIT XXX.

Statement showing loss in limit gauge levels under 1926 conditions, entailed by the adoption of the 10 years' average, the 3 years' average and the 7¼ years' average.

Limit gauges that should be ensured before impounding.	Ten years' average.		Three years' average		Seven and a quarter years' average.		Loss in level by the adoption of		
	Discharges.	Corresponding gauge on 1926 curve.	Discharges.	Corresponding gauge on 1926 curve.	Discharges.	Corresponding gauge on 1926 curve.	Ten years' average.	Three years' average.	Seven and a quarter years' average.
3.0	6,520	2·75	6,170	2·67	5,380	2·50	0·25	0·33	0·50
3·5	9,110	3·24	8,930	3·21	7,650	2·98	0·26	0·29	0·52
6·0	26,900	5·41	25,000	5·24	23,500	5·11	0 59	0·76	0·89
6·5	32,000	5·85	29,800	5·66	28,400	5·54	0·65	0·84	0 96
7·0	37,600	6·34	35,000	6·11	33,700	6·00	0·66	0·89	1·00
7·5	43,300	6·83	40,200	6·56	39,100	6·47	0 67	0·94	1·03

MADRAS EXHIBIT XXXI.

Statement showing variations of actual gauged discharges from the accepted discharges—1923.

Gauging No.	Date.	Cauvery Dam North Gauge Reading.	Area.	Mean velocity.	Gauged discharge.	Discharge as per accepted table.	Difference.	Percentage.
	1923.							
75	8th Oct.	4 70	4,487	2·10	9,426	10,900	— 1,474	— 13·5
76	9th ,,	4·47	4,330	1·92	8,317	9,766	— 1,449	— 14·8
77	10th ,,	4·42	4,363	1·99	8,665	9,526	— 1,861	— 9·0
78	11th ,,	4·24	4,138	1·79	7,391	8,716	— 1,325	— 15·2
79	12th ,,	4 02	4,003	1·72	6,889	7,756	— 867	— 11·2
80	13th ,,	3·95	3,938	1·66	6,530	7 460	— 930	— 12·5
81	15th ,,	3·59	3,680	1·59	5,853	6,033	— 180	— 3·0
82	16th ,,	3·57	3,644	1·68	6,109	5,959	150	2·5
83	17th ,,	3·69	3,867	1·82	7,032	6,412	620	9·7
84	19th ,,	3·49	3,660	1·64	5,967	5,665	302	5·3
85	20th ,,	3·53	3,696	1·68	6,209	5,811	398	6·8
86	22nd ,,	3·52	3,714	1·65	6,135	5 774	361	6·3
87	23rd ,,	3·51	3,678	1·76	6,489	5.737	752	13·1
88	24th ,,	4·18	4,284	2·32	9,922	8,452	1,470	17·4
89	25th ,,	4·62	4,618	2·47	11,385	10,008	1,377	13·8
90	26th ,,	4·84	4,713	2·85	13,442	11,640	1,802	15·5
91	29th ,,	4·00	4,194	2·71	11,381	7,670	3,711	48·4
92	30th ,,	4·51	4,815	2·79	13,433	9,959	3,474	34·9
93	31st ,,	4·53	4,623	2·74	12,653	10,057	2,596	25·8

MADRAS EXHIBIT XXXII.

Sketch map of the Cauvery from the Amaravathi infall to the Grand Anicut (showing Kodingal channel which conveyed the Murungapet breach water back to the river). (Not printed.)

MADRAS EXHIBIT XXXIII.

Note comparing levels of breaches and the Cauvery bed level at Murungapet.

Here is a plan showing the Kanavanur and Murungapet breaches called by the general name of Murungapet breach. The two portions shown in the plan as longitudinal sections represent the channel portions along which most of the water that went along the general breaches found their way. Therefore, the two sections represent what is left of the natural ground after the eroding power of the water had had its effect. As one goes along from west to east, first in the western of the two breaches called the Kanavanur breach at the point noted 1,603 feet, the level of the eroded ground level is 236. As we go along, the level of the ground after erosion at places marked 1700, 1800, 1900, 2000, 2100, 2200, 2300, 2400, 2500, etc., is 232·5, 229, 225·3, 225·2, 225·2, 225·2, 225, 224·4 and 224, etc., and at 2861 it is 232·2. Thus, we have come to the eastern flank of the Kanavanur breach. Similarly, going from the western to the eastern flank of what is called the Murungapet breach,

we have opposite to what is marked as zero foot, a ground level after erosion of 231·8; at the point opposite to what is marked as 239, we have a ground level after erosion of 226·8. At point opposite to 439 the ground level after erosion is 225·8. At 839 it is 224; at 939 it is 221·2; at 1039 it is 219·3; at 1158 it is 228·5.

Now, we know that the theoretical bed level at the Cauvery Dam is 236·24, i.e., the same as the crest level of the Cauvery Dam. The distance from the Cauvery Dam to a point midway between the Kanavanur and Murungapet breaches is 5 miles. We know that the bed of the Cauvery falls at three feet per mile. So for 5 miles the fall should be 5 × 3 or 15 feet. Therefore the bed level opposite to the point about midway in the breached portion is 236·24 *minus* 15 = 221·24. So, the only point of those mentioned above that is below this bed level of 221·24 is the one at 1039 of the Murungapet breach section. As per the figures given above, here it is 219·3 against 221·24. At all the other places the eroded country level is higher than the average bed level of 221·24.

A. Krishnaswamy Ayyar.

MADRAS EXHIBIT XXXIII (*a*) to (*d*).

(*a*) Longitudinal and cross-sections of the Kanavanur and Murungapet breaches along the new railway line. (Not printed.)

(*b*) Site survey showing the two breaches at Murungapet. (Not printed.)

(*c*) Land plan for Murungapet breaches, Mutharasanallur village, Trichinopoly taluk showing also the diversion of flood bank. (Not printed.)

(*d*) Cross-section of the reclaimed wet fields and the Cauvery river in Mutharasanallur village near 34 miles 1 furlong. (Not printed.)

MADRAS EXHIBIT XXXIV.

(*a*) Site survey showing the lower and upper korambus at the Kilikkudu breach. (Not printed.)

(*b*) Tracing from the conservancy map of the Cauvery showing the Kilikkudu breach at 16 miles 2 furlongs of left bank. (Not printed.)

(*c*) Kilikkudu breach at 16/2 of the Cauvery left bank (site survey and cross-sections). (Not printed.)

(*d*) Water readings at the site of the Kilikkudu breach at 16 miles 2 furlongs of the left bank of the Cauvery during closing of the breach. (Not printed.)

MADRAS EXHIBIT XXXV.

Administration report of the Madras Public Works Department (Irrigation) for 1923–24—

Page 6, *paragraph* 30.— . . .

The old Vennar head at Uthamaseri three miles above the Grand Anicut, which was closed with a heavy bank when the present head at the Grand Anicut was constructed, and had in addition become completely silted up, was reopened to increase the supply to the Vennar. * * *

Administration report of the Madras Public Works Department (Irrigation) for 1924–25 (page 8)—

Paragraph 14.— . . .

At Murungapet, the Cauvery breached in five places washing away the trunk road, railway line, station yard and the buildings and water escaped into the drainage channel of Kodingal and Kodamurutti and back into the Cauvery breaching the flood bank between the municipal pumping station and the Kodamurutti bridge from land side. This breach caused a break in the municipal pumping main and resulted in a serious outbreak of cholera in Trichinopoly town with many fatalities.

* * * * *

The old Vennar head was opened with the object of diverting some of the flood into the Vennar and reducing the flood in the Coleroon. Some other minor breaches also occurred in the rivers Mudikondanar, Tirumalarayanar, Arasalar and Virasholanar which were subsequently closed.

MADRAS EXHIBIT XXXVI.

Dawson's Engineering Works of the Missisippi, page 81—Ring bund for closing breach. (Not printed.)

MADRAS EXHIBIT XXXVII.

The Cauvery-Mettur Reservoir Project—Index map (showing the Urachi gauging site and topography). (Not printed.)

MADRAS EXHIBIT XXXVIII (*a*) AND (*b*).

(*a*) Area gauge diagram—Urachi gauging station—1923. (Not printed.)

(*b*) Area gauge diagram—Urachi gauging station—1924. (Not printed.)

MADRAS EXHIBIT XXXVIII (*c*).

Note on the changes in sectional areas at Urachi in 1923 *and* 1924.

Urachi section near Erode 3 miles above Bhavani and 90 miles from the Cauvery Dam.

1923 flood 13 feet at Cauvery Dam.

Bed. Sand overlying rock and stiff soil—Scouring of the bed even in 1923 as is evident from the increased areas for particular gauges.

Before flood.	After flood.
3rd July 1923 for 5·98 reading area 3,512 square feet	29th October 1923 for the same reading area 5,135 square feet.
10th July 1923 for 10·72 reading area 7,845 square feet.	17th July 1923 for nearly the same reading 10·98 area 9,134 square feet.
23rd June 1924 for 8·51 reading area 7,334 square feet.	23rd August 1924 for nearly the same reading 8·49 area 9,214 square feet.
28th June 1924 for 5·09 reading area 4,341 square feet.	17th October 1924 for 5·12 reading area 6,416 square feet.

The sketch of 1924 [Exhibit XXXVIII (*e*)] shows scouring of 3 feet at particular points with a maximum of 6 feet and 2 feet on an average. At this place there is no scope for any breaches, because the river runs in a valley 26 to 30 feet deep.

A. KRISHNASWAMI AYYAR.

MADRAS EXHIBIT XXXVIII (*d*).

Statement of gauge readings and areas at Urachi from which curves are plotted.

Gauging number.	Date.		Gauge reading.	Area.
	1923 BEFORE FLOOD.			
2	July	2	4·63	2,366
5	,,	5	4·65	2,423
1	,,	1	4·87	2,545
6	,,	6	5·12	2,841
7	,,	7	5·14	2,858
4	,,	4	5·23	2,917
3	,,	3	5·98	3,512
8	,,	8	9·43	6,651
9	,,	9	9·63	6,841
10	,,	10	10·72	7,845
11 (Surface)	,,	11	11·45	8,504

Gauging number.	Date.		Gauge reading.	Area.
	AFTER FIRST FLOOD.			
13	July	17	10·98	9,134
16	,,	20	12·06	10,126
14	,,	18	12·39	10,366
15	,,	19	12·41	10,522
12	,,	16	12·42	10,407
17	,,	21	12·42	10,442
..	,,	15	14·49	12,206

No gauging between 22nd July 1923 to 22nd September 1923.

Statement of gauge readings and areas at Urachi from which curves are plotted—*cont.*

Gauging number.	Date.		Gauge reading.	Area.
	1923 AFTER SECOND FLOOD.			
69	November	19	2·95	2,578
68	,,	17	3·10	2,689
67	,,	16	3·42	3,002
66	,,	15	3·63	3,104
65	,,	14	3·70	3,170
64	,,	13	4·02	3,478
63	,,	12	4·04	3,477
62	,,	11	4·20	3,627
60	,,	9	4·32	3,722
41	October	17	4·37	3,790
56	November	4	4·39	3,788
58	,,	6	4·51	3,880
42	October	19	4·52	3,906
40	,,	16	4·54	3,899
55	November	3	4·67	4,044
38	October	14	4·71	4,068
44	,,	21	4·72	4,079
49	,,	26	4·79	4,092
37	,,	13	4·785	4,153
43	,,	20	4·80	4,130
36	,,	12	4·82	4,218
48	,,	25	4·83	4,170
39	,,	15	4·87	4,213
57	November	5	4·99	4,286
35	October	11	5·01	4,342
34	,,	10	5·17	4,528
47	,,	24	5·45	4,670
54	November	1	5·50	4,718
50	October	27	5·54	4,767
33	,,	8	5·55	4,818
32	,,	7	5·76	5,005
46	,,	23	5·78	4,949
31	,,	6	5·81	5,055
51	,,	29	5·98	5,135
52	,,	30	5·98	5,146
53	,,	31	6·00	5,181
45	,,	22	6·11	5,235
30	,,	5	6·08	5,247
29	,,	4	6·28	5,449
28	,,	3	6·37	5,529
27	,,	2	6·52	5,653
24	September	29	7·035	6,150
25	,,	30	7·10	6,167
26	October	1	7·27	6,318
23	September	28	7·93	6,928
18	,,	23	8·04	6,996
19	,,	24	8·23	7,149
22	,,	27	9·14	7,948
21	,,	26	10·87	9,585
20	,,	25	10·95	9,600
	1924.			
11	July	4	3.37	2,905
16	,,	10	3·72	3,127
10	,,	3	3·75	3,132
12	,,	5	3·73	3,152
15	,,	9	3·84	3,218
14	,,	8	4·09	3,439
8	,,	1	4·31	3,647
13	,,	7	4·47	3,765
7	June	30	4·47	3,795
9	July	2	4·90	4,146
6	June	28	5·09	4,341
5	,,	27	5·51	4,730
17	July	11	5·57	4,758
4	June	26	6·32	5,423
3	,,	25	7·44	6,391
2	,,	24	7·77	6,764
1	,,	23	8·51	7,334
18	July	12	8·65	7,404
20	,,	14	10·53	9,154
19	,,	13	10·96	9,474
	1924 AFTER FLOOD.			
82	September	30	8·83	9,753
80	November	25	3·10	4,584
83	,,	28	3·14	4,632
81	,,	26	3.18	4,649
85	December	1	3·21	4,720
86	,,	2	3·22	4,719
87	,,	3	3·29	4,790
79	November	24	3·39	4,846
90	December	6	3·40	4,849
89	,,	5	3·72	5,053
84	November	29	3·94	5,270
88	December	4	3·97	5,291
78	November	20	4·38	5,632
72	,,	12	4·47	5,745
60	October	31	4·45	5,749
44	,,	14	4·40	5,780
59	,,	30	4·53	5,838
45	,,	15	4·60	5,951
43	,,	13	4·66	5,976
71	November	11	4·68	5,907
61	,,	1	4·62	5,923
77	,,	19	4·72	5,948
63	,,	3	4·67	5,978
48	October	18	4·68	6,039
42	,,	11	4·74	6,066
41	,,	10	4·81	6,124
64	November	4	4·84	6,140
46	October	16	4·90	6,183
58	,,	29	4·96	6,230
57	,,	28	4·99	6,201
70	November	10	5·01	6,197
62	,,	2	5·04	6,275
40	October	9	5·03	6,297
47	,,	17	5·12	6,416
76	November	18	5·21	6,387
66	,,	6	5·54	6,700
38	October	7	5·50	6,742
69	November	9	5·62	6,731
39	October	8	5·59	6,791
65	November	5	5·73	6,872
67	,,	7	5·74	6,869
75	,,	17	5·75	6,874
49	October	19	5·85	7,024
68	November	8	5·93	7,027
37	October	5	5·91	7,110
50	,,	20	6·21	7,351
26	September	22	6·29	7,373
23	,,	19	6·43	7,410
38	October	7	5·50	6,742
56	,,	26	6·45	7,500
24	September	20	6·58	7,537
21	,,	17	6·64	7,569
74	November	16	6·56	7,574
35	October	3	6·69	7,786
73	November	15	6·78	7,789
22	September	18	6·99	7,889
25	,,	21	7·07	7,956
55	October	25	6·97	7,998
51	,,	21	7·04	8,138
54	,,	24	7·35	8,355
34	,,	2	7·39	8,405
52	,,	22	7·64	8,675
33	,,	1	7·97	8,864
53	,,	23	8·13	9,089
27	August	28	8·49	9,214
32	September	30	8·83	9,753
31	,,	29	9·14	9,985
28	,,	25	9·60	10,321
29	,,	26	10·01	10,743
30	,,	27	10·68	11,408

MADRAS EXHIBIT XXXVIII (*e*).

Cross section at Urachi gauging site before and after the 1924 floods. (Not printed.)

MADRAS EXHIBIT XXXVIII (*f*).

Table of discharges of the Cauvery at Urachi—1923, 1924 *and* 1925.

With reference to the site gauge at the right bank.

Gauge height.	Discharges in cusecs. 1923.	1924.	Percentage increase over the discharge of 1923.	1925.	Percentage increase over the discharge of 1923.
3·0	2,790	3,300		3,540	
3·5	3,600	3,940		4,260	
4·0	4,570	4,820		5,250	
4·5	5,680	5,900		6,230	
5·0	6,890	7,140		7,470	
5·5	8,230	8,520		8,820	
6·0	9,680	10,100		10,300	
6·5	11,300	11,900		12,000	
7·0	13,000	13,600		13,900	
7·5	15,000	15,500		16,100	
8·0	17,100	17,600	2·9 per cent.	18,400	7·6 per cent.
8·5	19,300	20,000		20,800	
9·0	21,600	22,600		23,300	
9·5	24,000	25,600		26,200	
10·0	26,500	28,800	8·0 per cent.	29,500	11·3 per cent.
10·5	29,400	31,900		32,900	
11·0	32,400	35,000	8·0 per cent.	36,500	12·7 per cent.
11·5	35,500			40,300	
12·0	38,900			44,400	14·1 per cent.
12·5	42,500			48,800	
13·0	46,400			53,800	19·5 per cent.
13·5	50,300			60,100	
14·0	54,200				
14·5	58,100				

MADRAS EXHIBIT XXXIX.

Comparison of discharges at the same stages for periods immediately before and after closing of the Murungapet breach (1924).

If the Murungapet breach had had any effect on the discharges there would have been a distinct fall in the discharges for the same gauge reading after the breach was closed. For purpose of comparison at similar stages both before and after the breach was closed, we may take the gauging Nos. 37 to 50 (before the breach was closed, though not quite before the days when a start had been made on the arrangements for closing the breach) and gauging Nos. 51 to 58 (as representing the conditions after closing the breach). In the former case the gauge readings vary from 6·01 to 4·32 and in the latter from 5·42 to 4·35. The percentage variations from the discharges as per accepted curve for the period do not show any violent change towards the negative side for the observations after the breach was closed. Hence it must be concluded that the breach has had no effect on the discharges at the Cauvery Dam. Another set of three gaugings within the above stages Nos. 72 to 74 in November are available and an examination of these also confirms the above view.

Variations of the Gauged Discharges of August, September and November 1924 from the accepted discharge curve of 1924, (After floods.)

Date. (1)	Gauging number. (2)	C.D.N. gauge. (3)	Gauged discharge. (4)	Discharge as per curve. (5)	Difference. (6)	Percentage. (7)
August 1924—						
17th	37	6·01	37,332	36,010	1,322	3·7
18th	38	5·60	30,718	31,400	— 682	— 2·2
19th	39	5·56	31,038	30,960	78	0·3
20th	40	5·28	27,967	28,000	— 33	— 0·1
21st	41	5·00	24,436	25,200	— 764	— 3·0
22nd	42	5·05	25,102	25,700	— 598	— 2·3
23rd	43	4·94	24,345	24,660	— 315	— 1·3
24th	44	5·44	29,918	29,640	278	0·9
25th	45	5·28	27,550	28,000	— 450	— 1·6
26th	46	5·39	28,955	29,100	— 145	— 0·5
27th	47	5·07	25,408	25,900	— 492	— 1·9
28th	48	4·99	25,006	25,110	— 104	— 0·4
29th	49	4·60	21,238	21,700	— 462	— 2·1
30th	50	4·32	18,229	19,460	— 1,231	— 6·3
September 1924—						
3rd	51	4·35	19,257	19,700	— 443	— 2·2
4th	52	4·96	25,539	24,840	699	2·8
5th	53	5·15	27,416	26,700	716	2·7
6th	54	4·93	24,289	24,570	— 281	— 1·1
7th	55	5·06	25,664	25,800	— 136	— 0·5
8th	56	5·42	30,845	29,420	1,425	4·8
9th	57	5·24	28,208	27,600	608	2·2
10th	58	4·77	24,660	23,130	1,530	6·6
November 1924—						
3rd	72	5·60	30,154	31,400	— 1,246	— 4·0
4th	73	4·94	24,263	24,660	— 397	— 1·6
5th	74	4·67	23,121	22,260	— 861	— 3·9

MADRAS EXHIBIT XXXIX (*a*).

Cauvery Dam—1924—Discharge before and after the closing of the Murungapet breach—Curve showing—. (Not printed.)

MADRAS EXHIBIT XL.

Examination of Srirangam Nattu Voikal headsluice readings.

This channel takes off about three-fourths of a mile above the Murungapet breach from the left margin of the river. The water registers of the headsluice and the daily water reports submitted to the Executive Engineer are available for the years 1924 and 1925. An examination of the register and the daily water-cards show the extent to which the Murungapet breach, which looms so largely in the view of Mysore as having affected the regime of the river and the discharges at the Cauvery Dam, affected the water levels in the river. The results show conclusively enough the very little reduction in water levels in the river caused by the breach.

The breach at Murungapet occurred on the 17th or 18th July 1924. It was finally closed by the first week of September as shown by the remark of the Mysore Executive Engineer in the joint gauging note for the year 1924. A commencement would have been made on the closing of the breach by means of horses, etc., from about the 16th August and the actual operation of closing commenced from, say, the 23rd. For the period when the breach remained without any obstruction, we have got readings of the Srirangam Nattu Voikal headsluice from the 21st July to 22nd August when the readings at the Cauvery Dam North Gauge varied from 5·05 to 14·0. For the period of the year 1924 after the breach was closed we have got only a few readings for stages above 4·8. These are only up to a stage of 5·95 and are shown in the 1925 plottings in red. But to compensate for this, we have got a number of readings at this stage and even lower for the year 1925. By comparing the statement of discharges of the 1925 season with that of the after-flood period of 1924, it would be seen that the curves for the two years practically agree within these limits ; if anything, the discharges of 1925 are slightly greater than those of 1924. Hence it may be taken that for the period of 1924 after, say, 3rd of September, if any gauge readings in this vicinity are not available, we would be justified in assuming the gauge levels as taken from the readings of the year 1925, corresponding to similar Cauvery Dam readings, to be those actually obtained after the first

week of September 1924. The corresponding gauge readings of the Cauvery Dam North Gauge and the Srirangam Nattu Voikal headsluice for the period 21st July to 22nd August 1924 have been plotted on one sheet and a relation curve drawn (curve A) and a similar curve has been drawn for the year 1925 (curve B). The comparative results are tabulated below :—

Cauvery dam North Gauge reading.	Reading on Srirangam Nattu Voikal head-sluice, 1925, from curve B.	Probable reading on Srirangam Nattu Voikal head sluice after 3rd September 1924.	Reading on Srirangam Nattu Voikal head-sluice between 21st July and 3rd September 1924, from curve A.
5·0	6·98	6·98	6·60
5·5	7·58	7·58	7·23
6·0	8·14	8·14	7·83
7·0	9·22	9·22	8·90
8·0	10·31	10·31	9·84
9·0	11·37	11·37	10·68

The readings of 1924 after the closing of the breach which are within a stage of 4·8 to 6·0 (maximum reached after the closing of the breach) have been plotted on the sheet B in red and the points agree very fairly with the lie of the 1925 points, which would support the assumption made above that the discharge curves of 1925 and 1924-A at the Cauvery Dam North Gauge within the limits specified above practically coincide. On 3rd November 1924, for a gauge reading of 5·92 at the Cauvery Dam North Gauge, the Srirangam Nattu Voikal headsluice read 8·0. As per curve A for the same Cauvery Dam reading, the headsluice would have read 7·74, i.e., as the result of the breach there has been a drop of 0·26 in the water levels at the head sluice.

By comparing the readings in columns 3 and 4 of the tabular statement given above, it will be seen that the effect of closing the breach was only to raise the reading at the headsluice by about 0·69 at the most within the limits of the stages we have taken above. It is only 0·39 for the Cauvery Dam gauge reading of 7·5, the maximum reading we are concerned with. When the effect in lowering the water level was so small within a distance of ¾ of a mile from the breach it would have been quite imperceptible at the Cauvery Dam.

If the scour in the reach of the Cauvery between the Cauvery Dam and the Murungapet breach had been caused mainly by the breach, the main river below the breach site would not have been scoured to any appreciable extent. The depth of scour at the Cauvery Dam was 1·50 feet as we know. The depth of scour lower down would have been greater and greater as we approached nearer to the breach; and in consequence the scour opposite to the Srirangam Nattu Voikal headsluice must have been much greater than 1·50. The result of closing the breach would have been to raise the water level in the river below the breach site to suit the unscoured bed there, i.e., by 1·50 and this would have been reflected in the gauge readings at Srirangam Nattu Voikal headsluice after the breach was closed. As we see the rise is only 0·39 which is best explained by the fact that the fall in water levels due to a breach is more or less local, being greatest at the site of the breach and rapidly diminishing as we go higher up the river.

MADRAS EXHIBIT XL (*a*) *and* (*b*).

XL. (*a*) Relation curve of the Cauvery Dam North Gauge and Srirangam Nattu Voikal front gauge for 1924 (to show what depressions in level had taken place as a result of the Murungapet breach discharge). (Not printed.)

XL. (*b*) Relation curve of the Cauvery Dam North Gauge and Srirangam Nattu Voikal front gauge for 1925. (Not printed.)

MADRAS EXHIBIT XLI.

Probable discharges for 7·5 gauge for 1917—1923 assuming that the Cauvery Dam had no silt on it.

There is a simple way of roughly testing if the discharges of 1924 and 1925 were simply due to the scouring of the general bed of the river and were in no way, specially abnormal on account of the breach in the Dam. We know, from each year's

gaugings during the non-breach period, the discharge corresponding to a specific limit gauge, say 7·5. This discharge is with a certain depth of silt over the crest of the Dam, the depth of silt varying from time to time. The average area at the gauging section and the width of the river at the gauging site, corresponding to this limit gauge, can be arrived at from the gauging records. From these figures, we can work out the approximate discharge at the Cauvery Dam for the gauge reading of 7·5, on the basis that the river had scoured out all the silt over the Dam.

Adopting Manning's formula $Q = \frac{1 \cdot 486}{N} \times A \times D^{2/3} \times \sqrt{S}$, where N and S remain constant, the discharge will vary as $A \times D^{2/3}$. We know the area and D at the gauging section for the observed discharges. We know also the area and D at the Dam site on the basis that all the silt over the crest of the Dam had been scoured away. As the Dam and the gauging section are within 880 feet of each other, we may take it that the surface fall is constant within this short distance. Thus, S is taken as constant within this distance. We shall also, for the present, assume that N is the same at the two sections. Proceedings on this basis, we have

$$Q_1 = \frac{Q \times A_1 \times D_1^{2/3}}{A \times D^{2/3}}$$

where Q_1 = discharge at the Cauvery Dam with all silt removed, A_1 = area at the Cauvery Dam for the same condition, D_1 = mean depth at the Cauvery Dam for the same condition.

For a broad river, the hydraulic mean radius is practically the same as the mean depth.

For the purpose of these calculations, for 7·5 gauge, we take from amongst the observed results, only those that are closest to 7·5, i. e., we take the actual observations from 7·25 to 7·74 and get at an average result from these. For the year 1918, there are no observations close to the limit gauge of 7·5; hence, the results have been worked out from the records for the nearest gauge 7·0. The results are given in the attached sheets of calculations and are abstracted below :—

Year.	Approximate discharge for 7·5 gauge without any silt over Dam. Cusecs.
1917	55,424
1918	57,584
1919	51,880
1920	51,595
1921	50,722
1922	58,681
1923	53,211
Average	54,157

In the above, the assumption has been made that the value of N at the Dam site is the same as that at the gauging section. We know from a consideration of the irregularity at the latter and greater regularity in section at the former, that the value of N will be considerably smaller at the Cauvery Dam and in consequence the discharge would be much greater than the figure of 54,157 cusecs worked out above. Thus the actual discharges that we notice during 1924 and 1925, would have been realized with the scoured condition of the bed, even though the Dam had not breached.

Calculations.

<u>1917</u> $Q = 39500 ; A = 11530 ; D = \frac{11530}{1965}$;

$$Q = C \times A \times D^{5/3} \times \sqrt{S}$$

At the Dam site for the full area, we have $A_1 = 14076 ; D_1 = \frac{14076}{1950}$

$$Q_{17} = \frac{39500 \times 1965^{2/3}}{11530^{5/3}} \times \frac{14076^{5/3}}{1950^{2/3}} = 55424.$$

<u>1918</u> $Q = 35500 ; A = 10588 ; D = \frac{10588}{1976}$;

$$Q_{18} = \frac{35500 \times 1976^{2/3}}{10588^{5/3}} \times \frac{14076^{5/3}}{1950^{2/3}} = 57584.$$

1919 $Q = 40200$; $A = 12163$; $D = \frac{12163}{1983}$; $A_1 = 14076$; $D = \frac{14076}{1950}$;

$$Q_{19} = \frac{40200 \times 1983^{2/3}}{12163^{5/3}} \times \frac{14076^{5/3}}{1950^{2/3}} = 51880.$$

1920 $Q = 38100$; $A = 11802$; $D = \frac{11802}{1978}$;

$$Q_{20} = \frac{38100 \times 1978^{2/3}}{11802^{5/3}} \times \frac{14076^{5/3}}{1950^{2/3}} = 51595.$$

1921 $Q = 37700$; $A = 11847$; $D = \frac{11847}{1977}$;

$$Q_{21} = \frac{37700 \times 1977^{2/3}}{11847^{5/3}} \times \frac{14076^{5/3}}{1950^{2/3}} = 50722.$$

1922 $Q = 37800$; $A = 10899$; $D = \frac{10899}{1989}$;

$$Q_{22} = \frac{37800 \times 1989^{2/3}}{10899^{5/3}} \times \frac{14076^{5/3}}{1950^{2/3}} = 58681.$$

1923 $Q = 39300$; $A = 11851$; $D = \frac{11851}{1998}$;

$$Q_{23} = \frac{39300 \times 1998^{2/3}}{11851^{5/3}} \times \frac{14076^{5/3}}{1950^{2/3}} = 53211.$$

Average of 1917 to 1923

	55,424
	57,584
	51,880
	51,595
	50,722
	58,681
	53,211
Total	379,097

Average is 379097 ÷ 7 = 54,157.

MADRAS EXHIBIT XLI (*a*).

Areas at Gauging site for 7·50 gauge at the Cauvery Dam north gauge.

Abstract.

Years.	Area at ganging site for 7·50 gauge at C.D.N.
1917	11,530
1918	10,588 for 7·0 gauge
1919	12,163
1920	11,802
1921	11,847
1922	10,899
1923	11,851
1924 (after flood)	14,750
1925	15,135
1926	13,696

	Gauging number.	C.D.N. gauge.	Area sq. ft.	Water width at gauging site.
1917	83	7·51	11,704	1,968
	87	7·38	11,235	1,967
	102	7·40	11,236	1,960
		22·29	34,175	5,895
	Average ...	7 43	11,392	1,965
	Area for 7·5 gauge.		11,530 *sq. ft.*	
1918	81	7·17	10,968	1,980
	82	7·03	10,530	1,977
	83	7 21	11,099	1,978
	Average ...	7·14	10,865	1,978

Area for 7·0' gauge 10,588 *sq. ft.*

	Gauging number.	C.D.N. gauge.	Area sq. ft.	Water width at gauging site.
1919	3	7·28	11,488	1,978
	4	7·27	11,424	1,980
	37	7·27	12,353	1,985
	78	7·74	12,706	1,987
	79	7·26	11,888	1,983
	124	7·33	11,457	1,984
		44·15	71,316	11,897
	Average ...	7·36	11,885	1,983
	Area for 7·5 *gauge* 12,163 *sq. ft.*			
1920	28	7·59	12,161	1,983
	32	7 31	11,046	1,968
	33	7·495	11,515	1,981
	34	7·444	11,649	1,978
	35	7 30	11,885	1,977
	36	7·26	11,369	1,978
		44·40	69,625	11,865
	Average ...	7·40	11,604	1,978
	Area for 7·5 *gauge* 11,802 *sq. ft.*			
1921	34	7·63	11,936	1,971
	35	7·28	11,075	1,969
	37	7 30	10,998	1,970
	41	7·38	11,363	1,976
	42	7·55	11,823	1,979
	46	7·52	11,722	1,982
	47	7·69	12,051	1,981
	48	7·35	11,428	1,979
	49	7·60	11,808	1,980
	50	7·26	11,263	1,977
	55	7·31	11,428	1,978
	56	7·63	12,205	1,980
	57	7·39	12,0[illegible]9	1,978
	60	7·47	12,451	1,981
	61	7·54	12,529	1,980
	64	7·34	12,011	1,974
	65	7·44	12,326	1,975
	109	7·32	11,237	1,974
	112	7·61	11,465	1,980
		141·61	223,218	37,564
	Average ...	7·45	11,748	1,977
	Area for 7·5 *gauge* 11,847 *sq. ft.*			
1922	16	7·38	10,600	1,986
	25	7·74	11,640	1,994
	28	7·31	10, 92	1,983
	120	7·36	10,567	1,993
		29 79	43,199	7,956
	Average ...	7·45	10,800	1,989
	Area for 7·5 *gauge* 10,899 *sq. ft.*			
1923	16	7 42	11,315	1,991
	17	7·28	11,197	1,992
	19	7·36	11,350	1,997
	22	7·42	11,300	2,002
	35	7·27	12,571	2,000
	39	7 25	11,341	1,999
		44·00	69,074	11,981
	Average ...	7·33	11,512	1,997
	Area for 7·5 *gauge* 11,851 *sq. ft.*			

	Gauging number.	C.D.N. gauge.	Area sq. ft.	Water width at gauging site.
1924	23	7·68	14,553	1,984
	32	7·60	14,910	1,987
	33	7·38	14,660	1,984
	34	7·63	15,433	1,988
		30·29	59,556	7,943
	Average ...	7·57	14,889	1,986
	Area for 7·5 gauge 14,750 *sq. ft.*			
1925	11	7·71	15,559	2,019
	Area for 7·5 gauge 15,135 *sq. ft.*			
1926	5	7·26	13,166	2,022
	9	7·40	13,706	2,023
	21	7·27	12,718	2,022
	32	7·265	13,113	2,028
	33	7·615	14,718	2,020
	40	7·35	13,350	2,020
	41	7·53	13,426	2,022
	Total ...	51·690	94,197	14,157
	Average ...	7·384	13,457	2,022
	Area for 7·5 gauge 13,696 *sq. ft.*			

MADRAS EXHIBIT XLI (*b*).

Parker "The Control of Water"—Pages 472—474 (Manning's formula).

(Not printed.)

MADRAS EXHIBIT XLI (*c*).

Sections at the gauging section and the Cauvery Dam to show the greater roughness at the former site.

(Not printed.)

MADRAS EXHIBIT XLII.

Note on drop-down curve showing the fall in the water level at various places above the Murungapet breach.

Let us examine how far the draw-off due to the Murungapet breach will affect the river above Murungapet: in other words, how far will the 'drop-down curve' dealt with in treatises on hydraulics, produced by the Murungapet breach, extend above it. Theoretically speaking, the back water curve say due to a dam like the Krishnarajasagara or even that due to an anicut, like the Madhavamanthri anicut, or a drop-down curve will extend to infinity (vide page 242 of Bellasis' Hydraulics) but for all practical purposes it is limited by the extent of accuracy it is desired to secure or that can be secured in practice. For the Cauvery Dam gaugings we are reading the gauge correct to ·01 of a foot i.e., 12 of an inch, and it is now proposed to find out the distance at which the drop will be 0·01.

From the note on the Srirangam Nattu Voikal, the drop in the water levels at the Srirangam Nattu Voikal Head sluice for a 7·5′ gauge reading at the Cauvery Dam is 0·39 of a foot.

From 1924 gaugings Nos. 23, 32, 33 and 34 it is seen that the average area for 7·5 feet gauge is 14,750 square feet, the average width is 1,986 feet and average depth is $\frac{14750}{1986}$ or 7·43 feet. For want of more exact data as at the time of the floods, the width of the river is taken to be constant, and the

bed fall, the usual fall of 3 feet per mile. The depth at Srirangam Nattu Voikal should be 7·43′ — 0·39 or 7·04 feet. Hence, the length of the drop-down curve may be calculated between the points where the depth increases from 7·04′ to 7·42.

Adopting the formula given in page 264 of Bellasis' "Hydraulics"

$$L = \frac{C^2 R^2 (D_1 - D_2 + h_v)}{V^2 - C^2 R S^1}.$$

where C is the coefficient in the formula $Q = C A \sqrt{RS}$.

L is the length within which the depth changes from D_1 to D_2,

V is the average velocity in the reach,

R is the hydraulic mean radius which may be taken to be the same as the depth,

S is the bed slope or 3′ per mile or 1/1760,

h_v the diminution in head, due to decrease in velocity.

In this case of a drop-down curve, the velocity increases and so, h_v is negative. Splitting the reach 7·04 to 7·42 into the following 9 :—

Reaches.	Depth.	Velocity.		C.
1	7·04	4·05		58·11
	7·05	4·04		58·14
			for 7·075	58·20
2	7·10	4·01		58·24
3	7·15	3·99		58·38
4	7·20	3·96		58·52
5	7·25	3·93		58·66
6	7·30	3·90		58·80
7	7·35	3·88		58·94
8	7·40	3·85		59·09
9	7·42	3·84		59·15

The corresponding velocity against each depth has been worked out from the formula

$$\frac{56600 \text{ (the accepted discharge for 7·5 gauge).}}{1986 \times \text{depth}}$$

Taking the reach where the drop-down curve has no influence.

$$Q = C A \sqrt{RS}$$

$$\text{or } C = \frac{56600}{1986 \times 7·42 \times \sqrt{7·42} \times \sqrt{\frac{1}{1760}}} = 59·15$$

Taking any of the reaches, say the second, let us find out C by trial and error.

$$h_v = \frac{(4·04)^2 - (4·01)^2}{64} = ·004$$

If C = 58·17

$$\text{Then } L = \frac{(58·17)^2 \times \frac{7·05 + 7·10}{2} \times (·05 - ·004)}{(4·025)^2 - (58·17)^2 \times 7·075 \times \frac{1}{1760}} = ·424$$

Now for this length S works out to

$$\left(\frac{424}{1760} + ·05\right)/424 = \frac{1}{1460}$$

and from $Q = C A \sqrt{RS}$,

$$\text{C works to } \frac{56600}{1986 \times 7·075 \times \sqrt{7·075} \times \sqrt{1/1460}} = 57·87$$

Take C = 58·44

$$\text{Then } L = \frac{(58·44)^2 \times \frac{7·05 + 7·10}{2} \times (·05 - ·004)}{(4·025)^2 - (58·44)^2 \times 7·075 \times \frac{1}{1760}} = 450$$

$S = \frac{1}{1470}$ and C works to 57·91.

Similarly if C is taken as 57·90, L works to 400, and S to 1/1443 and C to 57·55

Tabulating these results,

When C is taken as	C works out by the formulæ to	Difference.
58·44	57·91	·53
58·17	57·87	·30
57·90	57·55	·35

So, C may be somewhere near 58·17. Let us take it as 58·20. Now we have found out C to be 59·15 for 7·42 depth and it is 58·20 for 7·075 depth and so by the rule of three, it is worked out for other depths.

The length L of the first reach in which the depth will increase from 7·04 to 7·05, where

$$h_v = \frac{4·05^2 - 4·04^2}{64} = ·0013$$

$$L = \frac{(58·125)^2 \times 7·045 \times ·0087}{(4·045)^2 - (58·125)^2 \times 7·045 \times 1/1760} = 72·96 \text{ ft. say } 73 \text{ ft.}$$

2nd reach in which depth will increase from 7·05 to 7·10.

$$h_v = \frac{(4·04)^2 - (4·01)^2}{64} = ·004$$

$$L = \frac{(58·2)^2 \times (7·075) \times ·046}{(4·025)^2 - (58·2)^2 \times 7·075 \times 1/1760} = 426·5, \text{ say } 427 \text{ ft.}$$

3rd reach—depth increasing from 7·10 to 7·15.

$$h_v = \frac{4·01^2 - 3·99^2}{64} = ·0025$$

$$L = \frac{(58·31)^2 \times 7·125 \times ·0475}{4^2 - (58·31)^2 \times 7·125 \times 1/1760} = 514·6 \text{ ft. say } 515 \text{ ft.}$$

4th reach—depth increasing from 7·15 to 7·20.

$$h_v = \frac{3·99^2 - 3·96^2}{64} = ·0037$$

$$\text{and } L = \frac{(58·45)^2 \times 7·175 \times ·0463}{(3·975)^2 - (58·45)^2 \times 7·175 \times 1/1760} = 606·0, \text{ say } 606 \text{ ft.}$$

5th reach—depth increasing from 7·20 to 7·25.

$$h_v = \frac{3·96^2 - 3·93^2}{+\ 64} = ·0037$$

$$L = \frac{(58·59)^2 \times 7·225 \times ·0463}{(3·945)^2 - (58·59)^2 \times 7·225 \times 1/1760} = 780·6, \text{ say } 781 \text{ ft.}$$

6th reach—depth increasing from 7·25 to 7·30.

$$h_v = \frac{3·93^2 - 3·90^2}{64} = ·0037$$

$$L = \frac{(58·73)^2 \times 7·275 \times ·0463}{(3·915)^2 - (58·73)^2 \times 7·275 \times 1/1760} = 1,086·8, \text{ say } 1,087 \text{ ft.}$$

7th reach—depth increasing from 7·30 to 7·35.

$$h_v = \frac{(3·90)^2 - (3·88)^2}{64} = ·0024$$

$$L = \frac{(58·87)^2 \times 7·325 \times ·0476}{(3·89)^2 - (58·87)^2 \times 7·325 \times 1/1760} = 1,706·7, \text{ say } 1,707 \text{ ft.}$$

8th reach—depth increasing from 7·35 to 7·40.

$$h_v = \frac{3·88^2 - 3·85^2}{64} = ·0036$$

$$L = \frac{(59·01)^2 \times (7·375) \times ·0464}{(3·865)^2 - (59·01)^2 \times 7·375 \times 1/1760} = 3,443·9, \text{ say } 3,444 \text{ ft.}$$

9th reach—depth increasing from 7·40 to 7·42.

$$h_v = \frac{3·85^2 - 3·84^2}{64} = ·0012$$

$$L = \frac{(59·12)^2 \times 7·41 \times ·0188}{(3·845)^2 - (59·12)^2 \times 7·41 \times 1/1760} = 7,056·6, \text{ say } 7,057 \text{ ft.}$$

Total depth for the change from 7·04 to 7·42 = 15,697 ft. or 2·97 miles.

Abstracting the results we have—

Depth.	Distance between reaches in feet.	Total distance above Srirangam Nattu Voikal head sluice in feet.
7·04	0	0
7·05	73	73
7·10	427	500
7·15	515	1,015
7·20	606	1,621
7·25	781	2,402
7·30	1,087	3,489
7·35	1,707	5,196
7·40	3,444	8,640
7·42	7,057	15,697

i.e., the drop would have been reduced to 0·13 or about one-eighth of a foot, at a distance of 3,489 ft. above the head sluice about 5 furlongs and it would have been reduced to 0·03 at a distance of 8,640 ft. above the head sluice (about $1\frac{5}{8}$ miles).

MADRAS EXHIBIT XLII (*a*).

Drop-down curve for 7·5 Cauvery Dam North Gauge during 1924 with Murungapet breach open (not printed).

MADRAS EXHIBIT XLIII.

Merriman—Treatise on Hydraulics—page 288—Rugosity (Not printed).

MADRAS EXHIBIT XLIV.

Note on breaches.

Breaches normal feature of floods.

The breaches in the flood banks have really no bearing on the points at issue in this case, for they are the ordinary normal features of a river, like the Cauvery which is subject to heavy floods and inundations. There has been no high flood which has not caused breaches and the extracts from the District Gazetteers of Tanjore and Trichinopoly which have been already cited amply bear out the fact that from the earliest times there have been numerous floods in the Cauvery and each flood has been followed by breaches in the banks and in the controlling works.

Scouring at places where no breaches.

Mysore contends that the breaches in the flood banks, principally at Murungapet and Kilikkudu, brought about a large amount of scouring of the river bed. That the scouring is not due to the breaches will be evident from the circumstances and the consideration mentioned below. In the first place, there have been scourings in the river bed at places where there have been no breaches at all. For instance, take Urachi, which is about 90 miles above the Cauvery Dam. It is a reach of the river where the natural banks are very high and where in consequence there could have been no breaches. The bed of the river at the gauging section here is composed of sand overlying rock or stiff soil. The results of the joint gaugings at this place give the following:—

Gauge reading.	Area before floods of 1923.	Area after floods of 1923.	Area before floods of 1924.	Area after floods of 1924.
FT.				
11·0	8,100	9,700	9,500	11,700
10·0	7,150	8,750	8,600	10,750
8·0	5,350	7,000	6,850	8,900

It will be seen from the above that there has been a successive increase in the areas, gauge for gauge, after the comparatively high flood of 1923 and the very high flood of 1924 and consequently, there has been a successive increase in the extent of the scouring of the river bed.

Scouring due to high and prolonged flood and its velocity.

The increased scouring of the river bed is really due to the high and prolonged floods and to its high velocity. In high floods the bed gets scoured to a considerable extent and the higher and more prolonged the flood, the greater would be the scouring effect on the bed. Strange in his book on Irrigation, Roads and Buildings, says "The velocity depends "greatly upon the depth . . . when the velocity is retarded, silt is dropped and "when the velocity is increased, silt is picked up."

The flood of 1924 was of considerable magnitude and lasted for 13 days over 11·5 feet at the Cauvery dam and the velocity of the flood in the high stages was as much as 8 feet per second. So it is no wonder that it largely scoured the bed of the river.

Owing to the interception of silt at the Krishnarajasagara the water which issues out of the reservoir is in a more or less clear state and picks up more silt or sand from the bed of the river as it flows along.

Scouring effect of breach purely local.

Then again, it is well known that the scouring effect of breaches is purely local. The usual method of putting up a ring bund to close the breach will illustrate this phenomenon. The scouring effect of the breach on the river bed would be very small and practically negligible except in the immediate vicinity of the breach.

Now the two principal breaches of the flood banks on which Mysore relies are at Murungapet, 5 miles from Cauvery dam and at Kilikkudu, 16 miles away from the same place, and it will follow from the foregoing observations that it is impossible that the scouring effect of breaches at these two places would have extended to any considerable distance up the river.

Adjoining wet lands on a higher level than river bed.

In the case of the Murungapet breach, the adjoining wet lands are on a higher level than the river bed and the water flowing through the breach did not flow into the open low country. What is called the Murungapet breach really consists of two breaches and the plans and sections filed by Madras will show that the lowest point of one of the two breaches was really above the bed level of the river and that the lowest point of the other breach was only about 2 feet below the river bed—vide separate note already submitted. (Exhibit XXXIII).

Flood water rejoined the main river.

Then again the water that flowed through the breach rejoined the main river, three miles below, after finding its way into the Kodamurti, an affluent of the Cauvery river.

No variation in discharge before and after closing of breach.

If the breach were the cause of the increased scouring and consequently of increased discharges, gauge for gauge, at the Cauvery dam, the closing of the breach must have reduced the discharges. On the other hand we find that the discharges after the closing of the breach have not varied considerably from the discharges before the breach was closed. A note is also submitted upon this subject. (Exhibit XXXIX).

No substantial increase in water level after closing of breach.

If the breach had, as alleged, brought about an increased scouring and consequently increased discharges, it would be expected that as a result of the closing of the breach, the water level in the river would rise in proportion to the extent of the scouring. But as a matter of fact the readings of the Srirangam Nattu Voikal headsluice which is located at a place three-fourth mile above the Murungapet breach site, show that there is no such correspondence between the extent of the scouring and the increase in the water level. The depth of scour at the Cauvery dam was 1·5 feet and therefore the scour opposite to Srirangam Nattu Voikal head must have been greater than 1·5 feet if the scour in the river bed was due to the breach. As a result of the closing of the breach, however, we find a rise of 0·39 foot only for a gauge of 7·5 feet at the Cauvery dam, which again illustrates the fact that the fall in the water levels is also more or less local, being the greatest at the site of the breach and rapidly diminishing as we go higher up the river. If, at a distance of three-fourth mile, the fall was only 0·39 foot, it can easily be seen that at the Cauvery dam which is five miles away, there could not have been any appreciable fall in the water level.

Turning to the Kilikkudu breach, as mentioned already, it is too far away from the Cauvery dam to have affected the river bed or the discharges at the Cauvery dam. There are also the outstanding facts that even during all the days that the breach remained unclosed, a substantial supply of water was taken for irrigation 1 mile below the breach site and $1\frac{1}{2}$ miles above it, i.e., through the Cauvery-Vennar regulators and through the old Vennar head near Uthamaseri which had been opened for the purpose of diverting water for irrigation. This would not have been possible if there had been considerable scouring of the river bed in the higher reaches due to this breach. The effect of it must have been quite local and could certainly not have had any effect at the Cauvery dam.

Water taken both above and below breach.

The difference in level between the Coleroon and the Cauvery is only 7 feet and the theory of the gorge or the hollow put forward by Mysore is entirely without foundation.

Difference between Cauvery and Coleroon, only 7 feet.

12*th June* 1929.

A. Krishnaswami Ayyar,
Madras Counsel.

MADRAS EXHIBIT XLV.

"*Irrigation in the Madras Provinces*" *by Col. R. Baird Smith, F.G.S., published in* 1856.

(Extract) Page 23.

Referring to the plans for minute details, I need only mention here that this work (Cauvery dam) was executed in 1845, and that it consisted of a bar of masonry, 650 yards in length, carried across the mouth of the Cauvery. The level of the crown at the central portion was the same as that of the river bed, while 150 feet at each flank were raised from 1 foot to 18 inches above it.

MADRAS EXHIBIT XLVI.

Afflux and corrected discharges for the years 1924 *and* 1925.

We shall here examine the conditions of 1924 and 1925 from the following point of view. We know the discharges at the several gauge limits for the breached condition of the dam. For the particular discharge we can calculate what the affluxes would have been, had the dam been *intact*. For this purpose we take the limit gauge reading as the water level in rear of the dam, as the discharge corresponding to any water level below a masonry work would depend upon the general conditions of the river below the work. Proceeding on this basis we have to calculate what would have been the affluxes for the several limit gauge discharges of these two years. Take the limit gauge of 7·5 for 1924. The accepted discharge was 56,600 cusecs. The joint cross section at the dam site taken in January 1925 shows a silted area of 1,619 square feet on the left side of the dam. The average area at the gauging section for 7·5 gauge was 14,752 square feet. If the dam had existed *intact*, there would have been some silt over the dam, so long as the area of flow in rear was less than 14,076 square feet, the silt getting gradually washed out as the area in rear became greater. When the area came up to 14,076 square feet there would be no silt at all over the dam, if the flow between the two sections is taken to be uniform or steady flow for the time being. As the area in rear became greater than 14,076 square feet an afflux may be created at the dam similar to the afflux where a weir is built across a stream. Anyhow when the area of water section below is 14,076 square feet or more the silt remaining over the dam will get washed off, and for purpose of calculating the afflux we may take for the area available over the dam the theoretical area calculated from the longitudinal section of the dam without silt over any portions of it. In this connexion please see the remarks of Spring (Extract attached). The calculation of afflux then becomes an easy problem. Assume the afflux to be h, and v_a and h_a the velocity and head of approach. The formula to be applied is $Q = 3{\cdot}1 \times 1{,}950 \{(h + h_a{}^{3/2}) - h_a{}^{3/2} + C_2 \times 8 \times A \times \sqrt{(h + h_a)}$. In this, Q= 56,600; h_a can be calculated from V_a, the latter being arrived at from the total discharge and the sectional area immediately in front of the dam; A is the standard area over the dam for the limit gauge reading of 7·5, i.e., 14,076; and C_2 is the co-efficient for the submerged portion of the dam. In an ordinary weir C_2 is taken as 0·8. But here the ratio

becomes very small and as per Love's Hydraulics (page 30) as this ratio becomes smaller and smaller, the value of C_2 tends to unity and when the afflux is indefinitely small, the value of C_2 actually becomes unity. The afflux in this case works out to 0·08 as compared with a value of 7·50 for d. Hence, it is considered quite reasonable to use a value of ·90 for C_2. The case may be said to be similar to that of a bridge where a co-efficient of ·9 or even ·95 is used for finding out afflux. In this particular case, it is believed that a co-efficient of ·95 would be quite suitable; but not to press the point too much, a value of ·9 is adopted.

As regards the velocity of approach, we know the mean velocity at the gauging section, viz., $\frac{56,600}{14,752}$. From the conditions about steady flow already referred to, it may reasonably be taken that the area immediately in front of the dam, would have adjusted itself to such an extent by scouring as to get this area of 14,752 square feet for the water level above the dam including the afflux. That is, calling V the mean velocity at the gauging section, the velocity of approach at the dam may also be taken as V and this may be called V_a. On the basis, of this, h_a is worked out and then h; and it is observed that for the particular discharge of 56,600 cusecs at 7·5 on the gauge, the afflux is about 0·08. In fact, for the velocity of approach obtaining, the depth of water in rear and the afflux assumed, the total discharge comes to 56,809 cusecs, against only 56,600 required. Thus, we see that for a discharge of 56,600 cusecs, the gauge at the Cauvery dam (including afflux) would have read 7·58. We know that at about 7·5 stage, the difference in discharge for a change of 0·10 in gauge is 1,600 cusecs. Hence, with the dam in existence, a front gauge reading of 7·5 would have given 56,600 — $\frac{8}{10}$ × 1,600 = 55,320 cusecs.

From the details furnished in the calculations attached, it will be seen that it will be necessary to calculate the afflux only for the following stages:—

7·5 and 7·0 in 1924; and
7·5, 7·0, 6·5, 6·0 and 3·5 in 1925.

Detailed calculations for these are appended and the corrected discharges for the limit gauges, assuming the dam had been *intact*, are also worked out.

Extract referred to in paragraph 1.

"*River Training and Control on the Guide Bank system*" *by Mr. Francis J. E. Spring, C.I.F.*

Technical Paper No. 153.

CHAPTER VII—Page 33.

4. *How a narrowed river provides for itself an increased depth without appreciable afflux.*—The question is: Can we venture to narrow a river, trusting to its providing for itself a sufficiently large cross section to carry its full discharge, without undue scour or afflux? The answer is: Yes, we *can* do so, and as a fact *have* frequently done so, relying on the fact that the beds of the rivers in question are composed not of unerodible rock or clay, but of erodible incoherent sand which is momentarily deepened by the momentary increase in velocity caused by the smallest momentary afflux. For the afflux, which causes the increase in velocity and the concurrent increase in depth, is no more than momentary, it is not permanent, and cannot be permanent, and cannot even last an appreciable time, so long as the bed is erodible.

Afflux calculations.

Average areas and water widths.

1924 (After floods).

	Gauging number.	Stage.	Area of water way.	Water width.
		FT.	SQ. FT.	FT.
7·5 stage	23	7·68	14,553	1,984
	32	7·60	14,910	1,987
	33	7·38	14,660	1,984
	34	7·63	15,433	1,988
		30 29	59,556	7,943
	Average ...	7·57	14,889	1,986

Area for 7·5 stage = 14,889 — 1,986 × ·07 = 14,750.

	Gauging number.	Stage.	Area of water way.	Water width.	
		FT.	SQ.FT.	FT.	
7·0 stage	24	7·11	13,273	1,981	
	29	6·97	13,113	1,984	
	30	7·22	13,640	1,988	
	35	7·10	14,047	1,975	
		28·40	54,073	7,928	
	Average ...	7·10	13,518	1,982	

Area for 7·0 *stage* = 13,518 — 1,982 × ·10 = 13,320

	Gauging number.	Stage.	Area of water way.	Water width.	
6·5 stage	25	6·41	11,757	1,974	
	27	6·73	12,381	1,976	
	28	6·57	12,033	1,976	
	36	6·61	12,904	1,975	
		26·32	49,075	7,901	
	Average ...	6·58	12,269	1,975	

Area for 6·5 *stage* = 12,269 — 1,975 × ·08 = 12,111

	Gauging number.	Stage.	Area of water way.	Water width.	
6·0 stage	26	5·88	10,515	1,962	
	37	6·01	11,407	1,973	
		11·89	21,922	3,935	
	Average ...	5·945	10,961	1,967·5	

Area for 6·0 *stage* = 10,961 + 1,967·5 × ·055 = 10,853

	Gauging number.	Stage.	Area of water way.	Water width.	
3·5 stage	61	3·52	5,544	1,621	
	62	3·49	5,565	1,621	
	63	3·45	5,452	1,619	
	64	3·36	5,232	1,613	
	65	3·30	5,096	1,612	
	66	3·31	5,073	1,609	
	70	3·55	4,475	1,663	
	71	3·32	4,113	1,652	
	80	3·63	5,335	1,699	
	81	3·39	4,758	1,692	
	82	3·29	4,718	1,690	
	84	[3·68]	[5,853]	....	Gauging at the north end made at a contracted section away from the current meter line. Hence neglected.
	85	3·40	5,325	1,702	
		41·01	60,686	19,793	
	Average ...	3·42	5,057	1,649	

Area for 3·5 *stage* = 5,057 + 1,649 × ·08 = 5,189

	Gauging number.	Stage.	Area of water way.	Water width.	
3·0 stage	83	3·22	4,645	1,690	
	86	3·15	4,801	1,697	
	87	2·98	4,309	1,520	
	88	2·88	3,907	1,456	
	89	2·79	3,580	1,406	
	94	2·77	3,427	1,424	
		17·79	24,669	9,193	
	Average ...	2·965	4,111·5	1,532	

Area for 3 *feet stage* = 4,111·5 + 1,532 × ·035 = 4,165.

Abstract.

Cauvery dam North gauge.	Area at gauging site.	Standard area at Cauvery dam.
7·5	14,750	14,076
7·0	13,320	13,101
6·5	12,111	12,126
6·0	10,853	11,151
3·5	5,189	6,276
3·0	4,165	5,301

Since the area at the Cauvery dam is less only at the stages of 7·5 and 7·0, calculations for afflux are necessary for these stages alone.

7·5 stage. Discharge = 56,600 ; Velocity of approach = $\frac{56,600}{14,750}$ = 3·84.

Head of approach = 0·23 ; Area = 14,076.
Try afflux 0·08
$(h + h_a)^{3/2} = (0·31)^{3/2} = 0·173$; $h_a^{3/2} = (0·23)^{3/2} = 0·110$.
$(h + h_a)^{3/2} - h_a^{3/2} = 0·063$.

$Q = 3·1 \times 1,950 \times 0·063 + ·9 \times 8 \times 14,076 \times (·31)^{1/2}$
$= 381 + 56,428 = 56,809$.

The assumption that h = ·08 is correct.

7·0 stage. Discharge = 48,800 ; Velocity of approach = $\frac{48,800}{13,320}$ = 3·66.

Head of approach = 0·21 ; Area = 13,101.
Try afflux ·06.
$(h + h_a)^{3/2} = 0·140$; $h_a^{3/2} = 0·096$.
$(h + h_a)^{3/2} - h_a^{3/2} = 0·044$.

$Q = 3·1 \times 1,950 \times ·044 + ·9 \times 8 \times 13,101 \times (·27)^{1/2}$
$= 266 + 49,014 = 49,280$.
Try h = ·05.
$(h + h_a)^{3/2} = 0·133$; $h_a^{3/2} - 0·096$.
$(h + h_a)^{3/2} - h_a^{3/2} = 0·037$.

$Q = 3·1 \times 1,950 \times ·037 + ·9 \times 8 \times 13,101 \times (·26)^{1/2}$
$= 224 + 48,098 = 48,322$. Afflux of ·05 will not do.
∴ Afflux = ·06.

1925

Average areas and water widths.

	Gauging number.	Stage.	Area of water flow.	Water width.
7·5 stage	11	7·71	15,559	2,019

Area for 7·5 *stage* = 15,559 — 2,019 × ·21 = 15,135.

	Gauging number.	Stage.	Area of water flow.	Water width.
7·0 stage	19	7·15	13,740	2,015
	20	6·80	13,146	2,015
	21	6·80	12,799	2,013
	50	6·91	12,966	2,019
	51	7·05	13,300	2,019
	52	7·13	13,620	2,019
	53	7·11	14,170	2,019
	110	7·03	13,425	2,020
	123	6·84	13,096	2,019
		62·82	120,262	18,159
	Average ...	6·98	13,362	2,018

Area for 7·0 *stage* = 13,362 + 2,018 × ·02 = 13,402.

	Gauging number.	Stage.	Area of water flow.	Water width.
6·5 stage	10	6·35	12,716	2,008
	22	6·37	11,591	2,007
	54	6·25	12,343	2,012
		18·97	36,650	6,027
	Average ...	6·32	12,217	2,009

Area for 6·5 *stage* = 12,217 + 2,009 × ·18 = 12,579.

	Gauging number.	Stage.	Area of water flow.	Water width.
6·0 stage	1	5·95	11,278	2,004
	30	6·00	10,626	2,009
	36	5·79	11,055	2,007
	49	5·86	10,723	2,010
	124	5·99	11,590	2,012
		29·59	55,272	10,042
	Average ...	5·92	11,054	2,008

Area for 6·0 *stage* = 11,054 + 2,008 × ·08 = 11,215.

63

	Gauging number.	Stage.	Area of water flow.	Water width.
3·5 stage	60	3·62	7,542	1,997
	61	3·52	7,371	1,995
	72	3·36	6,843	1,993
	73	3·44	7,076	1,996
	75	3·69	7,731	1,998
	81	3·31	6,728	1,992
	116	3·63	6,400	2,001
		24·57	49,691	13,972
	Average ...	3·51	7,099	1,996

Area for 3·5 *stage* = 7,099 − 1,996 × ·01 = 7,079.

	Gauging number.	Stage.	Area of water flow.	Water width.
3·0 stage	6	2·97	5,635	1,935
	62	3·04	6,065	1,985
	63	2·97	5,590	1,976
	64	[2·92]	Contracted section.	
	65	[2·83]	Do.	
	66	[2·97]	Do.	
	67	[2·88]	Do.	
	68	3·00	5,697	1,989
	69	3·03	5,698	1,989
	70	3·01	5,652	1,989
	71	2·97	5,308	1,912
	74	3·22	6,296	1,990
	82	3·07	5,459	1,980
	83	2·92	4,836	1,964
	84	2·81	4,391	1,893
	85	[2·79]	Contracted section.	
	93	2·99	4,855	1,954
	94	2·92	4,393	1,952
	98	2·78	3,587	1,773
	100	3·02	4,759	1,973
	101	[2·82]	Contracted section.	
	102	2·95	4,222	1,936
	103	2·95	4,146	1,959
	104	[2·78]	Contracted section.	
	117	3·21	5,735	2,000
	118	3·04	5,408	1,880
	119	3·16	5,769	2,001
	120	2·92	4,941	1,864
	121	2·83	4,627	1,813
		65·78	113,069	42,707
	Average ...	2·99	5,139·5	1,941

Area for 3·0 *stage* = 5,139·5 + 1,941 × ·01 = 5,159.

Abstract.

C.D.N. gauge.	Area at gauging site.	Standard area at the Cauvery Dam.
7·5	15,135	14,076
7·0	13,402	13,101
6·5	12,579	12,126
6·0	11,215	11,151
3·5	7,079	6,276
3·0	5,159	5,301

Since the area at the Cauvery Dam is less only at the stages of 7·5, 7·0, 6·5, 6·0 and 3·5, calculations for afflux are necessary for these stages alone.

7·5 stage. Discharge = 55,400.

Velocity of approach $= \frac{55,400}{15,135} = 3·66$.

Head of approach = 0·21.

Area = 14,076.

Assume afflux to be 0·09.

$(h + h_a)^{3/2} = 0·164$; $h_a^{3/2} = 0·096$.

$(h + h_a)^{3/2} - h_a^{3/2} = 0·068$.

$Q = 3·1 \times 1,950 \times ·068 + ·9 \times 8 \times 14,076 \times (·30)^{1/2}$

$= 411 + 55,510 = 55,921.$

Assume afflux to be 0·08.

$(h + h_a)^{3/2} = 0·156$; $h_a^{3/2} = 0·096$.

$(h + h_a)^{3/2} - h_a^{3/2} = 0·060$.

$Q = 3·1 \times 1,950 \times ·06 + ·9 \times 8 \times 14,076 \times (·29)^{1/2}$.

$= 363 + 54,577 = 54,940$; ∴ 0·08 is insufficient.

The afflux will be 0·09.

7·0 stage. Discharge = 49,100.

Velocity of approach = $\frac{49,100}{13,402}$ = 3·66.

Head of approach = 0·21.

Area = 13,101.

Assume afflux to be 0·06.

$(h + h_a)^{3/2} = 0·140$; $h_a^{3/2} = 0·096$.

$(h + h_a)^{3/2} - h_a^{3/2} = 0·044$.

$Q = 3·1 \times 1,950 \times ·044 + ·9 \times 8 \times 13,101 \times (·27)^{1/2}$

$= 266 + 49,010 = 49,276$.

Afflux = ·06.

6·5 stage. Discharge = 43,000.

Velocity of approach = $\frac{43,000}{12,579}$ = 3·42.

Head of approach = 0·18.

Area = 12,126.

Assume afflux to be 0·06.

$(h + h_a)^{3/2} = 0·118$; $h_a^{3/2} = 0·076$.

$(h + h_a)^{3/2} - h_a^{3/2} = 0·042$.

$Q = 3·1 \times 1,950 \times ·042 + ·9 \times 8 \times 12,126 \times (·24)^{1/2}$

$= 254 + 42,772 = 4[illegible],026$.

Thus afflux = 0·06.

6·0 stage. Discharge = 37,[illegible]0.

Velocity of approach = $\frac{37,[illegible]00}{11,215}$ = 3·30.

Head of approach = 0·17.

Area = 11,151.

Assume afflux to be 0·04.

$(h + h_a)^{3/2} = 0·096$; $h_a^{3/2} = 0·070$.

$(h + h_a)^{3/2} - h_a^{3/2} = 0·026$.

$Q = 3·1 \times 1,950 \times ·026 + ·9 \times 8 \times 11,151 \times (·21)^{1/2}$

$= 157 + 36,792 = 36,949$. Afflux of 0·04 will not do.

Thus afflux = 0·05.

3·5 stage. Discharge = 14,500.

Velocity of approach = $\frac{14,500}{7,079}$ = 2·05.

Head of approach = 0·07 ; Area = 6,276.

Assume an afflux of 0·04.

$(h + h_a)^{3/2} = ·036$; $h_a^{3/2} = ·019$.

$(h + h_a)^{3/2} - h_a^{3/2} = ·017$.

$Q = 3·1 \times 1,950 \times ·017 + ·9 \times 8 \times 6,276 \times (·11)^{1/2}$.

$= 103 + 14,987 = 15,090$.

Assume an afflux of 0·03.

$(h + h_a)^{3/2} = 0·032$; $h_a^{3/2} = ·019$.

$(h + h_a)^{3/2} - h_a^{3/2} = ·013$.

$Q = 3·1 \times 1,950 \times ·013 \times ·9 \times 8 \times 6,276 \times (·10)^{1/2}$

$= 79 + 14,289 = 14,368$.

∴ Afflux = 0·04.

Abstract.

Limit gauge.	Afflux. 1924.	Afflux. 1925.
7·5	0·08	0·09
7·0	0·06	0·06
6·5	Nil.	0·06
6·0	Nil.	0·05
3·5	Nil.	0·04
3·0	Nil.	Nil.

Thus the discharges will have to be corrected for the above figures.

	Gauge as corrected.	Discharge.	Limit gauge.	Discharge as corrected.
1924	7·58	56,600	7·50	55,300
	7·06	48,800	7·00	47,900
1925	7·59	55,400	7·50	53,200
	7·06	49,100	7·00	48,300
	6·56	43,000	6·50	42,300
	6·05	37,000	6·00	36,400
	3·54	14,500	3·50	14,100

MADRAS EXHIBIT XLVI (*a*) *to* (*d*).

(*a*) Col. Love's Hydraulics—Drowned anicut—page 31. (Not printed.)

(*b*) Col. Love's Hydraulics—Co-efficient for discharge of bridge openings—page 34. (Not printed.)

(*c*) Col. Love's Hydraulics—Afflux—page 35. (Not printed.)

(*d*) Col. Love's Hydraulics—page 38. (Example 9.) (Not printed.)

MADRAS EXHIBIT XLVII.

Enquiry into the storage of the Cauvery waters within Mysore territory—Vol. IV, pages 1—12—Madras appeal to the Government of India No. 200 I., dated 21st April 1915. (Not printed, but printed copies of the letter available separately.)

MYSORE EXHIBIT XLVIII.

Note on the working tables of Mysore for the Krishnarajasagara—
[Mysore Exhibits U and U_1.]

The following remarks are found in the tables furnished by Mysore regarding the working of the reservoir during the ten years 1917 to 1926 :—

Year.	With limit discharges based on the figures of 1917 to 1924 before floods.	With limit discharges based on the figures of 1917 to 1926.
1918–19 ...	The quantity impounded is, during the year, less than half the normal requirements of irrigation and power. The balance available at the end of the season is inadequate for working the reservoir during the commencement of the next season.	Reservoir fails from March to May 1919 and perennial crop suffers. It will be seen that by increasing the limit discharges, the loss in impounding during this bad year is about 5,000 millions cubic feet.
1919–20 ...	The year begins with a very low balance and perennial crops suffer. Issue to fresh irrigation is delayed. The balance available at the end of the season is inadequate for the normal working of the reservoir during the commencement of the next season. Thus, on the whole it is a bad year both at the commencement and end.	Reservoir fails in June and July 1919 and from October 1919 to end of May 1920 or in other words it fails completely.
1920–21 ...	Perennial crop suffers till the 25th June and monsoon irrigation has to be delayed ten days.	Reservoir fails in June and up to 10th July as the balance was *nil*.
1922–23 ...	Although the impounded quantity is less than the normal requirements the reservoir working is normal, due to the large balance at the beginning of the year.	Partial failure in May 1923.
1923–24 ...	Nil	Supply insufficient for irrigation in the commencement.

With a view to examine the correctness of these remarks, the figures in the working tables of Mysore for the three years 1918–19, 1919–20 and 1922–23 during which the reservoir did not fill have been verified.

Before summarising the results of the examination, the following facts have to be mentioned :—

(1) The figures for the inflow into the reservoir have been taken as the corrected inflow as found in the daily regulation statements, without applying any corrections for the co-efficients of discharges through the several sluices and the weir, etc., and for the rates of evaporation in the reservoir.

(2) With regard to the revised values of P, there are many points about which no agreement has been reached between Madras and Mysore ; so, the values furnished by Mysore have been taken without examining how far they are correct.

During the examination of the Mysore tables, the following points of difference were noticed between their method and the method adopted by Madras :—

(1) The rules of regulation require the tables to be prepared uniformly on a twelve hour basis, while Mysore has adopted in some cases twenty-four hour periods.

(2) With regard to the calculation of the impoundable quantity on the corrected inflow for the twelve hour period ending with 6 a.m. on the 27th of September, Mysore has adopted the October values of P and C. This is against the procedure adopted in actual regulation. Similarly, for other months also.

(3) Mysore has not adopted the reduction in supplies contemplated in their rules for working the reservoir as enunciated by them in Mysore Exhibits 27 and 30 (of the 1913-14 Arbitration) under different conditions of reservoir in the end of September and October.

(4) For calculating the draw-off for power during the summer months, Mysore has not adopted the joint instructions of the Executive Engineers.

As a result of these, the figures furnished by Mysore require revision and new statements have been prepared by Madras for the years mentioned above, showing the impoundable quantity, the requirements, and the balance. In revising the Mysore figures, the slight differences that will arise in the quantity of evaporation from the reservoir on account of the change in reservoir level, have been neglected. The following facts may be seen from these statements :—

(1) So far as the year 1918-19 is concerned, the supplies were very poor and whether with the seven years and odd figures or with the ten years' figures, the draw-off for irrigation should have been equally curtailed under case K.

(2) With regard to the year 1919-20 also, a certain amount of reduction in draw-off is necessary in both the conditions, but with the impounding under limit discharges based on the figures of 1917 to 1924 before floods, the reduction in supply comes under case C, while with the ten years' average conditions, the supply has to be reduced under case H. A statement has been appended showing in detail the reduced supplies under both the conditions.

(3) In both the cases, the balance at the commencement of the season 1920-21 is adequate and there can therefore be no difficulty in the working of the reservoir during that year.

(4) During the year 1922-23 also, a reduction in draw-off is found necessary under both the conditions ; but with the impounding under the average of seven years and odd the reduction comes under case C, while with the impounding under the average of ten years, the supply has to be reduced under case F. The reduced supplies under both the conditions have been shown in the accompanying statement.

(5) The opening balance in 1923-24 is ample in both the cases for the normal working of the reservoir and there is therefore no difficulty during the year.

It is thus seen that with both alternatives—

(i) The year 1918-19 is a bad year, when supplies to the irrigated area under the reservoir will have to be considerably diminished, the reduction being the same under both alternatives.

(ii) In 1919-20 and in 1922-23, the supplies from the reservoir have to be reduced under both alternatives, the degree of reduction being slightly greater with the ten years' average.

(iii) In 1920–21 and 1923–24 there will be no shortage at the commencement of the season if the reservoir be worked during the previous years as per rules already proposed by Mysore.

There will thus be under both alternatives severe shortage of supplies in one year and a reduction of supplies in portions of two other years, out of the ten-year periods examined; such deficits are inevitable in the case of any reservoir and are in no way special to the Krishnarajasagara.

Such a contingency, i.e., the possibility of the reservoir proving a minor or a major failure in some years was anticipated even at the commencement of the 1913–14 Arbitration and during the negotiations of 1920–21. Further it has to be noted that the year 1918–19 was the worst year on record as regards the supplies in the Cauvery, and the Cauvery delta suffered considerably as may be seen from the fact that a remission of Rs. 3,55,525 had to be granted in the Cauvery delta system for the year. As impounding in the Krishnarajasagara is not to be done before ensuring the requisite limit supplies for the existing irrigation in Madras, the occurrence of a failure of the reservoir during that year should not be taken as a standard for judging about its success or failure. Hence we need take only the remaining nine years for comparison.

It is seen that Mysore have stated in their note on the working tables (a statement which is not to be found in the printed statement of the Mysore case) that it is the Mysore case that the examination contemplated in rule 11 (ii) should also be restricted to 7½ years. Madras cannot accept this. It was understood throughout the negotiations that the examination contemplated for the verification and revision, if necessary, of P should be conducted for a period of ten years and the safeguarding of Madras against any material loss, which was the primary object of this examination, cannot be ensured by examining a total period of 57½ months as against a period of 80 months originally contemplated.

Abstract of the Krishnarajasagara reservoir working tables with the limit discharges based on the figures of 1917 to 1924 before floods.

Month.	Quantity impounded.	Draw off.	Balance.	Remarks.
		1917–18.		
October	...	...	44,655	
November	2,663	5,152	42,166	
December	1,933	4,383	39,716	
January	...	3,140	36,576	
Quantity depleted during summer ...		6,986	29,590	
		1918–19.		
June	1,006	3,172	27,424	
July	...	5,172	22,252	
August	6,708	5,143	23,817	
September	...	4,985	18,832	
October	...	2,984	15,848	Draw off reduced as per case K.
November	5,180	1,886	19,142	
December	7,698	1,307	25,533	
January	...	599	24,934	
Quantity depleted during summer ...		5,636	19,298	
		1919–20.		
June	4,915	2,076	22,137	
July	1,666	5,001	18,802	
August	24,521	5,135	38,188	
September	1,074	4,972	34,290	
October	1,181	5,130	30,341	Draw off reduced as per case C.
November	9,048	3,087	36,302	
December	1,241	2,258	35,285	
January	21	1,795	33,811	
Quantity depleted during summer ...		10,878	22,933	

Abstract of the Krishnarajasagara reservoir working tables with the limit discharges based on the figures of 1917 to 1924 before floods—*cont.*

Month.	Quantity impounded.	Draw off.	Balance.	Remarks
		1921–22.		
September	...	...	41,787	
October	2,806	5,301	39,292	
November	...	5,115	34,177	
December	...	4,328	29,849	
January	114	3,060	26,903	
Quantity depleted during summer ...		10,598	16,305	
		1922–23.		
June	...	3,056	13,249	
July	31,563	5,133	39,679	
August	5,908	5,301	40,286	
September	49	5,130	35,205	
October	233	5,270	30,168	Draw off reduced as per case C.
November	4,269	3,776	30,661	
December	429	3,198	27,892	
January	...	2,160	25,732	
Quantity depleted during summer ...		10,786	14,946	

Abstract of the Krishnarajasagara reservoir working tables with the limit discharges based on the figures of 1917 to 1926.

Month.	Quantity impounded.	Draw off.	Balance.	Remarks.
		1917–18.		
October	...	...	44,483	
November	1,929	5,145	41,267	
December	1,116	4,368	38,015	
January	...	3,124	34,891	
Quantity depleted during summer ...		6,986	27,905	
		1918–19.		
June	380	3,128	25,157	
July	...	5,146	20,011	
August	4,691	5,131	19,571	
September	...	4,950	14,621	
October	...	2,949	11,672	Reduced supplies as per case K.
November	3,709	1,831	13,550	
December	7,252	1,213	19,589	
January	...	531	19,088	
Quantity depleted during summer ...		5,636	13,422	
		1919–20.		
June	3,428	2,086	14,824	
July	882	4,935	10,771	
August	21,734	5,038	27,467	
September	623	4,905	23,185	
October	719	3,051	20,853	Reduced supplies as per case H.
November	7,089	2,527	25,415	
December	239	1,493	24,161	
January	102	410	23,853	
Quantity depleted during summer ...		6,180	17,673	
		1921–22.		
September	...	...	41,731	
October	1,212	5,301	37,642	
November	...	5,100	32,542	
December	...	4,290	28,252	
January	37	3,031	25,258	
Quantity depleted during summer ...		10,598	14,660	

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Abstract of the Krishnarajasagara reservoir working tables with the limit discharges based on the figures of 1917 to 1926—*cont.*

Month.	Quantity impounded.	Draw off.	Balance.	Remarks.
		1922–23.		
June	...	3,053	11,607	
July	28,698	5,133	35,172	
August	2,383	5,270	32,285	
September	...	5,070	27,215	
October	...	5,177	22,038	
November	2,296	2,969	21,365	Reduced supplies as per case F.
December	48	2,225	19,188	
January	...	1,609	17,579	
Quantity depleted during summer ...		6,502	11,077	

Statement of reduced supplies per day in million cubic feet during the years 1918–19, 1919–20 and 1922–23 from the Krishnarajasagara, allowed in the working tables as modified by Madras.

I. With limit discharges based on the figures of 1917 *to* 1924 *before floods.*

Month.	Normal supplies.		1918–19, Case K.		1919–20, Case C.		1922–23, Case C.	
	Monsoon crop.	Perennial crop.	Monsoon crop.	Perennial crop.	Monsoon crop.	Perennial crop.	Monsoon crop.	Perennial crop.
June second half to September second half.	103	54	103	54	146	11	103	54
October	103	54	51·5	27	146	11	103	54
November	103	54	34	18	73	11	51·5	54
December { First half	69	54	23	18	49	11	34	54
December { Second half	69	54	Nil	18	49	11	34	54
January { First half	51·5	54	Nil	18	36·5	5·5	26	27
January { Second half	Nil	54	Nil	Nil	Nil	54	Nil	54
February	Nil	54	Nil	Nil	Nil	54	Nil	54
March	Nil	54	Nil	11	Nil	54	Nil	54
April	Nil	54	Nil	11	Nil	54	Nil	54
May and June first half	Nil	54	Nil	11	Nil	54	Nil	54

II. With limit discharges based on the figures of 1917 *to* 1926.

Month.	Normal supplies.		1918–19, Case K.		1919–20, Case H.		1922–23, Case F.	
	Monsoon crop.	Perennial crop.	Monsoon crop.	Perennial crop.	Monsoon crop.	Perennial crop.	Monsoon crop.	Perennial crop.
June second half to September second half.	103	54	103	54	146	11	103	54
October	103	54	51·5	27	73	11	103	54
November	103	54	34	18	73	5 5	51·5	27
December { First half	69	54	23	18	33	5·5	34	27
December { Second half	69	54	Nil	18	33	5·5	34	27
January { First half	51·5	54	Nil	18	Nil	5·5	26	27
January { Second half	Nil	54	Nil	Nil	Nil	5·5	Nil	27
February	Nil	54	Nil	Nil	Nil	13·5	Nil	18
March	Nil	54	Nil	11	Nil	13 5	Nil	18
April	Nil	54	Nil	11	Nil	13 5	Nil	18
May and June first half	Nil	54	Nil	11	Nil	13·5	Nil	18

MADRAS EXHIBIT XLIX.

Note on Proportion Factor.

What is called the 'proportion factor' is the proportion which the inflow at the Krishnarajasagara bears to the general waters of the Cauvery or rather the inflow at the Cauvery Dam (for a moment taking it that there is no dam and there is no interception at the Krishnarajasagara), i.e., if the total waters of the Cauvery is taken as 1, the Madras contribution or the contribution below the Krishnarajasagara is taken as ·375.

The idea of the parties is to secure a particular flow to Madras out of the natural flow and to see that before Mysore impounds any waters Madras is secured that right. How to do it is the question If the requisite flow to Madras could be secured out of the contribution on this side of the Krishnarajasagara, it is all right. If not, the balance ought to be made good out of the inflow at the Krishnarajasagara and the formula is devised merely with a view to work out this principle. The I in the formula represents the quantity to be impounded at the Krishnarajasagara which is the thing to be determined. The P in the same formula is the proportion factor already referred to, viz., the proportion of the flow at the Krishnarajasagara to the total waters of the Cauvery at the Cauvery Dam. Kn is the inflow at the Krishnarajasagara and C is the flow connoted by the gauge reading for the particular month given in rule 7.

This formula

$$I = \frac{Kn}{P} - C$$

will apply to any state of circumstances.

To take the simplest illustration, we will take it that 35,000 cusecs is the quantity to be secured to Madras at the Cauvery Dam. We will assume the inflow at the Krishnarajasagara on any particular day to be 30,000 cusecs. Then, since for an inflow of 625 at the Krishnarajasagara the total quantity at the Cauvery Dam will be 1,000, it follows that for an inflow of 30,000 cusecs at the Krishnarajasagara, the total quantity at the Cauvery Dam would be 48,000 cusecs. And the balance of 18,000 cusecs will be made up by the inflow on this side of the Krishnarajasagara.

Now, 35,000 cusecs which is the quantity due to Madras will have to be secured by the 18,000 cusecs on this side of Krishnarajasagara and 17,000 cusecs from the Krishnarajasagara, i.e., 17,000 cusecs will have to be let out from the Krishnarajasagara and the impounding there will be 13,000 cusecs. You will find that the same result is worked out by the formula

I (13,000) is equal to $\frac{\text{inflow at Krishnarajasagara (30,000)}}{\text{P. (·625)}}$ minus C (35,000).

13,000 is equal to 48,000 minus 35,000.

Supposing the inflow at the Krishnarajasagara is 60,000 cusecs, then the total quantity at the Cauvery Dam would be 96,000 cusecs. In other words, 36,000 cusecs will be the inflow on this side of the Krishnarajasagara. Madras wants only 35,000 cusecs and therefore there is no necessity for any specific quantity being let out from the Krishnarajasagara. It will be observed that the same impounding formula leads to the same result. We started on the assumption that the entire flow could be impounded by Mysore.

Now $\frac{Kn}{P}$ — C in this case is $\frac{60,000}{·625}$ — 35,000

i.e., 96,000 — 35,000,

i.e., 61,000.

As a result of the formula, Mysore can impound 61,000 cusecs, whereas the inflow there is only 60,000.

The previous calculation proceeds on an assumed estimate of the proportion of the Krishnarajasagara inflow to the inflow at the Cauvery Dam based no doubt upon observations; but it is possible to conceive slight errors creeping into the calculations or into the actual measurements and therefore the parties provided that so long as the variation did not exceed 5 per cent the proportion factor was not to be disturbed.

In the first illustration, we proceeded on the footing that if 30,000 cusecs is the inflow at the Krishnarajasagara, 48,000 cusecs will be the inflow at the Cauvery Dam and to make up 35,000 cusecs at the Cauvery Dam, 18,000 cusecs would have to be contributed by the waters on this side of the Krishnarajasagara, 17,000 cusecs by the water let out from the Krishnarajasagara and 13,000 cusecs might be impounded at the reservoir as the result of the application of the impounding formula. But it is possible to conceive that Madras might really be getting 37,000 cusecs instead of 35,000 cusecs, in which event the proportion factor is not to be disturbed.

Or again, as the result of the impounding of the 13,000 cusecs at the Krishnarajasagara, Madras might be getting, say, 34,000 cusecs. Then, as the loss is only 1,000 cusecs (less than 5 per cent), the proportion factor is not to be disturbed. But if it goes very much below 34,000 (more than 5 per cent), it means there is something wrong in the formula and therefore to make the necessary adjustments the proportion factor will have to be increased.

If, as the result of the actual measurements near the Cauvery Dam, the observations show that by impounding 13,000 cusecs at the Krishnarajasagara, Madras is realizing very much more than 35,000 cusecs (quantity due to Madras), the proportion factor is not to be disturbed at all, as its value ·625 is an irreducible minimum.

A. Krishnaswami Ayyar,
Madras Counsel.

MADRAS EXHIBIT L.

Note on how the breach in the Cauvery Dam would have occurred.

To show how the breach in the dam occurred, the following explanations which are both based on high authority are offered :—

1. Just before the floods occurred, the dam was buried in about two feet depth of sand as in sketch A.* As the flood rose and the velocity increased, the sand over the dam got gradually scoured away, until the crest level was reached—sketch B.

As the flood rose still higher, the sand both above and below the dam got scoured by the increased velocity; and in addition to this another factor came in—*vide* sketch C. The dam stood as an obstruction to the flow of water in the deep scoured portion and this caused further scouring just below the dam. The effect can be realized by anybody who has stood in the sandy bed of a river while water was flowing; on account of the obstruction caused by the observer's legs, the sand immediately below gets scoured.

This general lowering of the bed both above and below the dam by the increased velocity, and the special local scour immediately below the dam went on increasing (*vide* sketch D) as the flood rose to its maximum, until at about the maximum stage of the flood, the dam got breached—*vide* sketch E.

When the flood fell again, the velocity rapidly fell and the charge of silt in the flood water was greater than what the velocity could admit, and the suspended silt got deposited rapidly as the water level fell down, until by the 2nd August for which date we have got actual observations of the bed level, the average bed level was actually above the crest level of the dam. Thus, the bed level of the river got scoured down to below the crest level during the stages of maximum flood, but it got filled up again by the time we began to take observations for the stages with which we are concerned. At that time, i.e., the 2nd August, the breach at Murungapet still remained unclosed—in fact, no attempt had been made to make a start on the work by that date—and the fact that after the maximum stages of the flood, the river bed got again silted up to about the crest level of the dam would show that the intermediate scour between the 17th July and the 2nd August that caused the breach in the dam, was not due to the breach at Murungapet.

2. The other explanation proceeds on the basis that the sand which is found in the beds of most large Indian rivers, is in motion to considerable depths during high floods. During high floods, it is not only the water that is moving, but it is believed that the sandy bed below is also in motion. The depth to which this motion in the sandy bed goes down, depends upon the height of the flood. In the case of a very high flood, this depth may be greater than the depth at which masonry works across the river are founded (we are dealing now with what are technically termed shallow-foundation works) and when this state of things occurs, the work stands upon something like quick sand, sinks into it, breaks up and gets damaged or destroyed. The extracts from Stoney's paper on "Extraordinary floods in Southern India", which are appended to this note and which give the opinions of many eminent engineers who have worked in India, would explain the main idea underlying this theory. It is believed that in high floods, the sandy bed is more or less what may

* *Sketches A to D*—Exhibit L (*c*)—*not printed.*

be called "moving slurry" and if the depth to which the bed sand is affected by this phenomenon goes below the foundations of a masonry work across the river, the work is damaged.

As the flood level falls, the depth of this "moving slurry" gets reduced, until we come to the stage which is under our normal observations, when the bed is not moving, though the sand particles at the surface may be picked up and carried away by the water, or rolled along the bed of the stream.

On this theory such a state of things as described above would have occurred at the maximum stage of the Cauvery flood, and the Cauvery dam got damaged. But when the moving stage ceased and when we were able to take actual observations, we see that the average bed level is above the crest level of the dam.

Under both these hypotheses, whether we take the breach in the dam to be due to scour or to the sand bed itself moving as a whole, the actual fact remains that the river bed on the first day we start our observations after the flood, is above the crest level of the dam.

MADRAS EXHIBIT L (*a*).

Extract from Mr. E. W. Stoney's paper on Extraordinary floods in Southern India.

Page 4—*Mr. Stoney.*—Another difficulty is that due to the great depth of fine sand found in the beds of most large Indian rivers. This is always saturated with water, and the author believes, in motion to considerable depths during high floods.

Page 10—*Mr. Stoney.*—It may be safely assumed that, during this flood, most, if not all, of the top layer of sand was in motion round piers Nos. 2 to 5 when these were carried away.

Page 26—*Col. Pennycuick.*—In order to estimate the discharge of a river of that sort in high flood when there was a very ill-defined river bed, still more when there was an ill-defined section, and when the exact depth at which the sand was moving was not known, was exceedingly difficult.

Page 33—*Mr. Vernon-Harcourt.*—If it was considered that the rivers referred to in the paper were not only flowing with water, but also that the sand was in movement, as had been noticed before now in the Mississippi where sand-waves travelled down the river—and the larger the flood the deeper was the movement—it was evident that eventually there must be scour leading to the undermining of some of the piers which were founded at a comparatively small depth in the sand.

Pages 51-52—*Mr. Thomson.*—It would be interesting to learn from the author whether, in calculating the flood discharge, any allowance was made for the abnormal increase of channel section due to the flow of the river bed. It was generally believed that the river bed was in motion to a very great depth; so much so that to this cause was attributed the complete disappearance of a passenger train . . .

Page 53—*Mr. Waring.*—In both cases the upper strata were most unstable and specially liable to removal by scour in times of flood.

Page 55—*Mr. Waring.*—Every Engineer who had had tropical experience must be painfully and fully aware of the great damage caused by exceptional rainstorms and floods, and how difficult, if not indeed impossible, it was at all times to guard against it.

Page 55—*Mr. Stoney.*—These sandy river beds were found charged with water up to or near their surface, even in the dry season; so that it was reasonable to suppose that a considerable flow took place during floods below the normal river bed, and that the sand was also moving—consequently calculations of discharge during high floods could at best be but very approximate.

MADRAS EXHIBIT L (*b*).

Extracts from the Minutes of the Proceedings of the Institute of Civil Engineers, Volume 218 (*page* 160).

Mr. Frederick Newhouse remarked :—

Apart from turbulence and errors in current meter rating, the two chief sources of error in taking the discharges of a big river in flood were due to errors in sounding

and to unsteadiness of the boat from which observations were being taken . . . The Nile in flood carried a very large volume of silt in suspension and in all probability near the bed of the river there was a thick slurry moving with the stream. The question arose whether this slurry, which was practically a moving bed, was to be considered as part of the water carrying cross-section of the river."

MADRAS EXHIBIT L (*c*).

Sketch to explain the breaching of the Cauvery dam (not printed).

MADRAS EXHIBIT L (*d*).

Query by the Arbitrator and the reply of Madras.

Justice PAGE: Mr. Advocate-General, is this what you mean? It is conceded, as indeed it must be conceded, that at the time of the flood or at some previous time, there were breaches in the south part of the dam. Such breaches on the Cauvery could not have been effected, unless the sand had been scoured away to the crest of the dam beforehand. The result is that to the extent to which the south end of the dam was breached, there would be an increased area through which the water could flow. That area is stated to be the area of the water of the river at 7·5 after the breach and is stated by Mysore to be 16,450. This cannot be so, because the state of the river was substantially the same, 900 feet below at the meter gauge section and by joint actuals obtained in August 1924, the average area is found to be 14,750. Therefore, it must have been no more than 14,750 at the dam, or a little less.

Yes.

Therefore, taking this plan submitted by Mysore, showing the various bed levels at different times in different colours, there must have been a far greater shoal on the north side of the dam than any shoal appearing in the plan as drawn. And for this reason you contend that it is really immaterial whether the gauging was taken at the dam, or at the meter gauge section; or elsewhere in the river and there is no magic in the dam as the particular point at which the gaugings took place.

The shoal need not have been necessarily greater than any shoal appearing on the plan, if the breached portion had been quite clear of sand at 7·5 stage. After the stage of maximum flood, when the dam got breached, had passed sand would have filled up to a greater or less extent, the hollows in the breached portion (just as we see that these have been filled up in the section of January 1925); and if the hollows had not got filled right up to the crest level, the effective area of waterway in the breached length below the crest level would not have been greater than the shoal on the north side.

Anyhow, having regard to the area at the current meter section, corresponding to a reading of 7·5 at the Cauvery Dam, it is quite clear that 16,450 square feet could not have been the effective area of waterway at the dam at the same time. It may be that, as shown in the annexed note, (Exhibit L.) the bed level might have gone below the crest level at the maximum stage of the flood, but it had soon regained the crest level, as is seen by the actual figures for the 2nd August. In other words, the area mentioned in the Mysore plan could not have been the effective area of waterway on that date (2nd August) or later, and the bed level on that date could not have been 235·30.

MADRAS EXHIBIT LI.

Plan of the Cauvery Dam at the Upper Anicut showing the crest level of dam as restored in 1926 (Not printed).

MADRAS EXHIBIT LII.

Site survey of the $\frac{\text{gauging operation}}{\text{current meter section}}$ at the Upper Anicut (not printed).

MADRAS EXHIBIT LIII.

Correspondence relating to the Cauvery Arbitration Negotiations with Madras—March 1920 to August 1923—Volume I.

(*a*) Mr. Howley's letter, dated 2nd and 4th May 1920, page 4 (not printed).

(*b*) Mr. Cadambi's letter, dated 5th May 1920, page 4 (not printed).

(*c*) Mr. Howley's letter, dated 5th and 6th May 1920, on limit gauges, page 5 (not printed).

(*d*) Mr. Howley's letter, dated 6th May 1920—Safeguarding Madras interests and relative unimportance of Mysore project, page 6 (not printed).

(*e*) Mr. Howley's final offer of limit gauges, page 7 (not printed).

(*f*) Mr. Howley's letter, dated 27th May 1920, regarding the limit gauges, essence—gauges, not discharges (not printed).

(*g*) Table showing limit gauges and discharges (page 9) (not printed).

(*h*) Mr. Cadambi's letter, dated 24th July 1920, accepting limit gauges, page 17 (not printed).

(*j*) Mr. Howley's letter, dated 18th September 1920, enclosing note as to limit gauges, etc., page 31 (not printed).

(*k*) Mr. Cadambi's letter, dated 29th September 1920, page 35 (not printed).

(*l*) Rules of Regulation reference to conditions of Upper Anicut shutters, page 41 (not printed).

(*m*) Mr. Cadambi's demi-official, dated 31st October 1920, regarding Rules of Regulation, Rule 1—Regulation of Upper Anicut Shutters, pages 50–51 (not printed).

(*n*) Resident's demi-official to Mr. Banerjee, 18th November 1920 that Madras insists on limit gauges for all time, page 62 (not printed).

(*p*) Rules of Regulation. Madras accept proposal on pages 51 and 63 (not printed).

(*q*) Demi-official from the Mysore Chief Engineer to the Chief Engineer, Madras, dated 27th January 1921, page 69 (not printed).

MADRAS EXHIBIT LIV.

Correspondence between Madras and Mysore relating to the gauging in connexion with the breaches at the Cauvery dam after the floods of 1924.

(*a*)	Letter, dated	8th November 1924.	Printed separately.
(*b*)	Do.	1st December 1924.	
(*c*)	Do.	16th April 1925.	
(*d*)	Do.	2nd June 1925.	
(*e*)	Do.	2nd October 1925.	
(*f*)	Do.	21st January 1926.	
(*g*)	Do.	20th May 1926.	
(*h*)	Do.	31st March 1927.	
(*j*)	Do.	19th August 1927, paragraph 10 only.	

MADRAS EXHIBIT LV.

Quantity represented by the difference between the ten years' and seven and a quarter years averages.

Number of impounding days at the Krishnarajasagara during the five year period 1917–1922.

—	June.	July.	August.	September.	October.	November.	December.	January.
1917–18	1	½	1½	7	27½	7	7½	..
1918–19	2	..	6	..	..	7½	12½	..
1919–20	5	2½	8	1½	1½	15	7	5
1920–21	5½	22	6½	..	..	4	..	..
1921–22	4	4½	20½	6½	4½	1	..	2
Total impounding days ..	17½	29½	42½	15	33½	34½	27	7
Average number of days per year	3½	6	8½	3	6½	7	5½	1½=41½
Ten years average limit discharge..	32,000	43,300	43,300	37,600	32,000	26,900	9,110	6,520
Seven and quarter years and average limit discharge ..	28,400	39,100	39,100	33,700	28,400	23,500	7,650	5,380
Deficiency ..	3,600	4,200	4,200	3,900	3,600	3,400	1,460	1,140
Total cusecs ..	12,600	25,200	35,700	11,700	23,400	23,800	5,110	1,710

Total in each year of 41½ impounding days 139,220

Cusecs for 41½ days 3,355

MYSORE-MADRAS CAUVERY ARBITRATION—1929

FINAL AGREEMENT.

Whereas on the 18th February 1924 an agreement between the Governments of Mysore and Madras was signed and whereas by clause 10 (2) of the said agreement, the Mysore Government agreed to regulate the discharges through and from the Krishnarajasagara Reservoir strictly in accordance with the Rules of Regulation being Annexure I to the said agreement and

Whereas disputes had arisen between the two Governments in regard to the interpretation operation and carrying out of rules 7 and 8 of the said Rules of Regulation and

Whereas both the Governments have submitted the matters in dispute to the arbitration of the Hon'ble Mr. Justice Page with Messrs. Howley and Forbes as Assessors

Now the two Governments have agreed in lieu of an award in that behalf to adopt finally for all regulation subsequent to 1st July 1929 the following discharges for the respective months in place of the average referred to in clause 8 of Annexure I :—

	CUSECS.
June for $6\frac{1}{2}$ feet gauge	29,800
July and August for $7\frac{1}{2}$ feet gauge	40,100
September for 7 feet gauge	35,000
October for $6\frac{1}{2}$ feet gauge	29,800
November for 6 feet gauge	25,033
December for $3\frac{1}{2}$ feet gauge	8,913
January for 3 feet gauge	6,170

and in rule 10 defining the impounding formula, C will denote the said above-mentioned discharges.

This agreement is without prejudice to the other questions outstanding between the parties in regard to the clauses of the agreement other than clauses 7 and 8 of the Rules of Regulation.

A. G. LEACH,
Secretary to Government, Public Works and Labour Department, Madras.

17*th June* 1929.

R. RANGA RAO,
Offg. Chief Secretary to the Government of Mysore.